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FY93

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U.S. Army Environmental Center
Aberdeen Proving Ground, MD 21010-5401
Project Officer: Mark Hampton (410) 671-1559

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The report summarizes the U.S. Army Environmental Center's activities in environmental technology to potential users within the Army and to research and development organizational counterparts in the other military services and to pertinent non-DOD federal agencies. In accordance with the DOD Enviromental Quality R&D Plan, these programs provide support for implementation of remedial actions at Department of Army installations; cost-effecctive reuse or recycling of waste, obsolete, or excess material; and more cost-effective treatment of toxic and hazardous wastes resulting from Army industrial activities.

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Introduction
and
Program Summary

I. INTRODUCTION

The purpose of this document is to enhance technology transfer by disseminating information relating to the current status and plans of the U.S. Army Environmental Center (USAEC) Environmental Quality Research and Development (R&D) Program. This information is intended primarily for personnel within the Department of Army, research and development counterparts in the other services, and other pertinent Federal agencies.

By presenting this information to users as well as other developers, duplication of effort by other R&D agencies with similar responsibilities and missions may be avoided. In addition, timely technology transfer can occur so that other developers may build upon the research results already obtained. Users can employ this information to establish plans for incorporating the best technology available and to allow them to perform their missions in an environmentally sound manner. Anyone reviewing this document who desires additional information should contact the designated point of contact (if it regards a specific development effort) or the responsible individuals listed on the Standard Form 298 in the front of this report.

II. PROGRAM SUMMARY

The USAEC's FY93 efforts described in this report represent a significant portion of the Army's total Environmental Quality Technology Program. USAEC projects are performed in close coordination with other Army organizations involved in the total program. In this regard, USAEC has the lead role for the Army in conducting field demonstrations of newly developed environmental technologies as well as subsequent technology transfer.

Approximately 75 percent of the USAEC FY93 program was dedicated to support the Army's installation cleanup program. The remainder was primarily devoted to new technology demonstrations and technology transfer in support of industrial operations conducted at Army ammunition plants and depots. Some of the technologies involved were generated in the private sector and adapted to Army use, while others were developed in-house. The FY93 efforts also included cost analyses and comparative evaluations to determine the best technology for particular applications.

USAEC policy places prominent emphasis on technology transfer to achieve rapid and effective field implementation of new technologies. Thousands of hours were spent by USAEC personnel in FY93 assisting major command and installation staffs, as well as the U.S. Army Corps of Engineers Divisions and Districts, in implementing new technologies. These technology transfer activities primarily consisted of providing technical data, performing pertinent cost analyses, preparing equipment fabrication and procurement guidance, and providing operator training and on-site consultations.

SUMMARIES OF TASKS

Alternatives to Open Burning/Open Detonation (OB/OD)

Point of Contact: Wayne E. Sisk (410) 671-1567, DSN 584-1567

Objective: To identify, evaluate, develop, and demonstrate alternatives to Open Burning/Open Detonation (OB/OD).

Approach: This project began with a survey of the quantities and types of materials processed by OB/OD operations. An evaluation of federal and private sector technologies was also conducted to determine applicable solutions. Both of these efforts indicated that the preparation and feed of energetic material to the destruction process were the critical elements of a feasible OB/OD alternative. Emerging destruction technologies are being monitored to determine their suitability for full scale use, and promising candidates will be transitioned to field demonstrations.

Value: With growing OB/OD restrictions, the Department of Defense's (DOD's) capability to treat energetic wastes is diminishing, and energetics disposal may be eliminated. To avoid the safety and security problems associated with a burgeoning waste energetics inventory, alternatives to OB/OD must be found. The capability to dispose of energetic materials economically will also ensure the continuation of munitions production.

Accomplishments to Date: A number of destruction technologies are currently under investigation by several federal agencies. Among the most advanced technologies are molten salt oxidation (U.S. Navy) and supplemental fuels use. This Center, in partnership with the U.S. Army Construction Engineering Research Laboratory, has developed the principle of hydromilling to process a waste stream for feed to a destruction mechanism.

Future Plans/Milestones:	
Hydromill pilot demonstration	April 1994
Hydromill pilot report	September 1994
Initial demonstration of destruction systems	September 1995
Assess second generation technologies	September 1996

Available Documentation: None

Composting of Explosives-Contaminated Soils

Point of Contact: Mark L. Hampton (410) 671-1559, DSN 584-1559

Purpose: To develop composting as a bioremediation technology to treat sites with explosives-contaminated soils and sediments.

Problem Addressed: A number of U.S. Army installations have sites with explosive-contaminated soils and sediments. Although incineration has been demonstrated as an effective treatment technology, the treatment costs are high.

Value: Composting offers an alternative biotreatment technology that has the potential to effectively degrade explosives in soil and sediment at a significantly lower cost than incineration. The residual material may be backfilled into the excavated site, and the site can be readily revegetated as part of the restoration effort.

Accomplishments to Date: The first field demonstration conducted at Louisiana Army Ammunition Plant in 1988 proved that composting of explosives can reduce trinitrotoluene (TNT), cyclo-trimethylenetrinitramine (RDX), and cyclotetramethylenetetranitramine (HMX) to acceptable levels. The final composted product from the Louisiana site was subjected to toxicological testing by the Army Biological Research and Development Laboratory (BRDL). The test data indicated that the finished compost exhibits little significant toxicity. An engineering cost analysis and process design was completed for the composting of explosives-contaminated soils. This analysis indicated the need for a field test to optimize conditions to achieve the most cost-effective composting process.

A pilot-scale optimization study was completed at the Umatilla Army Depot Activity (UMDA) in November 1991. Maximum soil throughput, amendment mixtures, and two types of composting processes: aerated static pile and mechanically agitated in-vessel composting, were investigated. Toxicological testing and chemical characterization studies were completed on the compost samples from the optimization study. Since the pilot-scale optimization test results indicate that mixing decreases process time significantly and leads to more extensive explosives degradation, a windrow pilot-scale field demonstration was initiated.

The optimization study results were so encouraging that composting was considered in a feasibility study in an interim Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial action to treat the explosives-contaminated washout lagoons at UMDA. These washout lagoons are currently on the National Priority List (NPL). Composting was selected as the remedial action of choice over the alternative, incineration. A Record of Decision has been signed to use composting to remediate the explosives-contaminated soils in the UMDA washout lagoons. The results of the windrow pilot-scale field demonstration will be used to develop a full-scale field demonstration design to be used at UMDA. The Corps of Engineers-Seattle District is responsible for the UMDA washout lagoon remediation project. However, because of the uniqueness of this technology, the first year of implementation will require the oversight of research and development personnel familiar with the technology.

Future Plans/Milestones:	
Amendment selection parameters report completed	February 1994
Lagoon rock decontamination report completed	February 1994
UMDA washout lagoon remediation contract awarded	March 1994
Bioremediation of UMDA NPL site completed	December 1995

Available Documentation:

Technical report, **Composting of Explosives,** U.S. Army Report DRXTH-TE, 1982.

Technical report, **Composting Explosive/Organic Contaminated Soils**, USATHAMA Report AMXTH-TE-CR-86077, May 1986.

Technical report, **Field Demonstration-Composting of Propellants-Contaminated Sediments at the Badger Army Ammunition Plant (BAAP)**, USATHAMA Report CETHA-TE-CR-89061, March 1989.

Technical report, **Proceedings for the Workshop on Composting of Explosives-Contaminated Soils**, USATHAMA Report CETHA-TS-SR-89276, September 1989.

Technical report, **Characterization of Explosives Processing Waste Decomposition Due to Composting**, U.S. Army Report ORNL/TM-11573, January 1990.

Technical report, **Evaluation of Composting Implementation: A Literature Review**, U.S. Army Report TCN-89363, July 1990.

Technical report, **Optimization of Composting for Explosives- Contaminated Soil**, USATHAMA Report CETHA-TS-CR-91053, November 1991.

Technical report, **Phase II, Characterization of Explosives Processing Waste Decomposition Due to Composting**, U.S. Army Report ORNL/TM-12029, November 1991.

Technical report, **The Preparation and Analysis of Soil Compost Material for Inorganic and Explosive Constituents**, USATHAMA Report CETHA-TS-CR-92067, October 1992.

Technical report, **Windrow Composting Engineering/Economic Evaluation**, USATHAMA, USAEC Report CETHA-TS-CR-93050, May 1993.

Technical report, **Site Demobilization of Composting Demonstration Facilities for Explosives-Contaminated Soils at Umatilla Depot Activity, Hermiston, Oregon**, USAEC Report ENAEC-TS-CR-93092, June 1993.

Technical report, **Windrow Composting Demonstration for Explosives-Contaminated Soils at the Umatilla Depot Activity, Hermiston, Oregon**, USAEC Report CETHA-TS-CR-93043, August 1993.

Technical report, **Compost Compaction Evaluation**, USAEC Report ENAEC-TS-CR-93110, October 1993.

Composting of Propellants and Propellant-Contaminated Soils

Point of Contact: Theodore E. Ruff (410) 671-1564, DSN 584-1564

Purpose: To develop composting as an environmentally acceptable method to dispose of waste nitrocellulose (NC) fines and to remediate soils contaminated with NC-based propellants.

Problem Addressed: There are several sources of NC that require disposal. A number of U.S. Army installations have soils contaminated with propellants because of formerly acceptable waste water disposal practices. There is also a significant quantity of NC fines stored at several Army installations. Finally, there are waste NC fines generated from current manufacturing operations. The current technology for disposing of NC fines is rotary kiln incineration. Although this incineration has been demonstrated as an effective treatment, costs are high and obtaining permits for incinerators is becoming difficult.

Value: Composting offers an alternative treatment technology for the following:

a. remediation of soils contaminated with NC fines
b. disposal of NC fines stored at Army facilities
c. disposal of fines generated from the production of nitrocellulose.

Although there is a proposed program to recycle waste fines from current manufacturing operations, a substantial quantity of waste NC fines is still expected to be generated.

Accomplishments to Date: An evaluation of various options for recovering and treating/disposing of nitrocellulose present in the manufacturing wash streams at the Radford Army Ammunition Plant (RAAP) indicated that biological treatment may provide a feasible alternative for the disposal of waste NC fines.

A field demonstration at Badger Army Ammunition Plant determined that composting can successfully biologically degrade the NC in soils contaminated with NC-based propellants.

An economic and process feasibility study of the composting of NC fines was performed that indicated that composting of NC fines is technically and economically feasible. In addition, significant progress has been made in the development of composting to remediate explosives-contaminated soils.

A hazards analysis is currently being performed to determine the reactivity of a compost pile consisting of pure NC fines, compost amendments, and moisture. This project is a precursor to a pilot demonstration of composting NC fines.

Future Plans/Milestones:	
Completion of hazards analysis	May 1994
Begin pilot demonstration	August 1994
Complete pilot demonstration	November 1994
Cost analysis completed	June 1995
Implementation guidance package completed	December 1995

Available Documentation:

Technical report, **Engineering/Cost Evaluation of Options for Removal/Disposal of NC Fines**, U.S. Army Report DAAK11-85-D-0008, September 1987.

Technical report, **Field Demonstration-Composting of Propellants Contaminated Sediments at the Badger Army Ammunition Plant (BAAP)**, USATHAMA Report CETHA-TE-CR-89061, March 1989.

Technical report, **Process and Economic Feasibility of Using Composting Technology to Treat Waste Nitrocellulose Fines**, USATHAMA Report CETHA-TE-CR-91012, March 1991.

Comprehensive Guide of Installation Restoration/Site Remediation Technologies

Point of Contact: Edward G. Engbert (410) 671-1575, DSN 584-1575

Purpose: The purpose of this report is to reduce duplicate technology transfer efforts among Government agencies and to provide the reader with "one stop shopping" for evaluating installation restoration technologies.

Problem Addressed: Several Department of Defense (DOD) and other Government agencies have created and maintained numerous separate technology transfer documents describing the development and status of installation restoration technologies. Several of these documents have similar designs and contain duplicate information.

Value: The DOD Environmental Technology Transfer Committee (ETTC) determined that it would be worthwhile to compile the best features of several existing environmental technology transfer documents into one compendium. This compendium will increase cooperation and reduce Government duplication as well as be designed to allow the reader to do "one stop shopping." In other words, it will provide guidance for a Remedial Project Manager to efficiently proceed from identifying a contaminated site to communicating and recommending suitable technologies for remediation of the site to environmental regulators. In addition, it will streamline the current research effort required by obtaining and sorting through several different documents.

Accomplishments to Date: The U.S. Army Environmental Center (USAEC) awarded a contract for the preparation of the handbook in December 1993. The handbook contract will be managed by the USAEC in cooperation with ETTC representatives from the Air Force, Navy, EPA, and DOE.

Future Plans/Milestones:	
Publish handbook	August 1994

Available Documentation:

Technical report, **Installation Restoration and Hazardous Waste Control Technologies,** 1992 Edition, USATHAMA Report CETHA-TS-CR-92053, November 1992.

Cone Penetrometer as a Subsurface Sensing Device

Point of Contact: George E. Robitaille (410) 671-1576, DSN 584-1576

Purpose: To provide a rapid means of characterizing subsurface contamination and reduce the number of monitoring wells and soil borings at a site, thus reducing site characterization costs.

Problem Addressed: In hazardous waste site assessments it is necessary to detect, delineate, and identify contaminants and to further characterize subsurface conditions. Current practice relies on a program of exploratory well drilling, installation of wells, and sampling, as well as laboratory analyses of soil and groundwater samples to obtain the needed information. Well installation, sampling, and sample analysis programs are expensive and contribute significantly to the overall cost of the DA Installation Restoration Program.

Value: Incorporating hazardous waste sensors with the cone penetrometer could provide an effective way to minimize costs. This could be accomplished by more effective monitoring of well placement as well as by a reduction of the number of wells required to perform site monitoring.

Accomplishments to Date: The Site Characterization and Analysis System (SCAPS) was funded as a tri-service project with money from the Army, Navy, and Air Force. Later, the Department of Energy (DOE) added funding to assess the system's advanced features at a DOE site.

A cone penetrometer truck designed for operations at a hazardous waste site has been procured and equipped with a grouting system that grouts each hole as the cone is withdrawn. The truck is also equipped with computer based data collection and reduction systems and cone tips that are equipped with sleeve friction and point pressure sensors that produce soil geological data. In addition, the truck also has conductivity and resistivity modules and a laser fiber optic sensor for detecting Petroleum, Oils, and Lubricants (POL). All this data can be collected on a continuous basis as the cone tip is pushed into the soil at a rate of one meter-per-minute. Computer software has been developed and tested to assimilate all data into a color three-dimensional plot of soil layering and contaminant concentration and location.

Field demonstrations of the advanced cone penetrometer system were conducted at a mixed waste site in Jacksonville, FL; a POL site at Tyndall Air Force Base, FL; a mixed waste site at Savannah River Plant DOE, SC; a POL site at the Philadelphia Navy Yard, PA; and multiple POL sites at FT. Dix, NJ and a POL- contaminated site at Sierra Army Ammunition Plant (SAAP). Extensive validation and verification studies were conducted in conjunction with a POL contaminated site demonstration at SAAP.

A SCAPS truck was built and transitioned to the U. S. Army Corps of Engineers, Kansas City District (KCD).

The first edition of a SCAPS operating/training manual has been produced and used to train the SCAPS team from KCD.

Future Plans/Milestones:	
Distribute final report of SAAP efforts	February 1994
Transition second Corps SCAPS truck to the Savannah District	March 1994
Develop alternative data processing/visualization software	March 1994
Transition third Corps SCAPS truck to the Tulsa District	May 1994
Facilitate a SCAPS workshop with the DOD, DOE, and Environmental Protection Agency (EPA) to develop better communication between agencies and reduce duplication in sensor development projects	June 1994
Winterize the SCAPS vehicle for operation at freezing temperatures	August 1994
Provide ongoing technical assistance to corps districts as required for SCAPS field operations	September 1994

Available Documentation:

Technical report, **Development of a Computerized Penetrometer System for Hazardous Waste Site Soils Investigations,** USATHAMA Report AMXTH-TR-TE-8842, August 1988.

Technical report, **Field Evaluation of the SCAPS at the Philadelphia Naval Shipyard,** USAWES Report GL-92-39, December 1992.

Technical report, **Use of the SCAPS at Grandville Michigan Superfund Site**, USAWES Report GL-92-38, December 1992.

Technical report, **Field Trials of the SCAPS at Savannah River (SRS)**, USAWES Report GL-93-16, July 1993.

Technical report, **Use of the SCAPS at the Walnut Creek Watershed, Ames Iowa,** USAWES Report GL-93-12, August 1993.

Technical report, **Site Investigations with the SCAPS, Fort Dix, NJ**, USAWES Report GL-93-17, September 1993.

Technical report, **Initial Field Trials of the SCAPS at Jacksonville Naval Air Station**, USAWES Report GL-93-30, December 1993.

Cooperative Efforts With The Private Sector

Point of Contact: Theodore E. Ruff (410) 671-1560, DSN 584-1560

Objective: To coordinate efforts being conducted by private sector and government elements to develop innovative remediation technologies.

Approach: As environmental problems are addressed, both the private and government sectors tend to develop solutions independently. These actions often result in duplication of effort and a failure to capture lessons learned. This inefficiency is most often seen during the feasibility study process when individual sites are closely examined, but no large scale application considerations are made. Additionally, since these studies are conducted on a site-specific basis, the results can not be evaluated against another site on an equal basis.

To overcome these limitations, this program will be based on a critical review of the key parameters that determine the effectiveness and cost of an emerging technology. Since this is a collective program, a common analysis and reporting format can be used and results applied on a broad scale. As more technologies and individual uses are examined, an applications and suitability matrix will emerge that captures the lessons learned as well as the effects of key parameters. Such parameters include site characteristics, contaminates, and operational variables. The transfer of this information and emerging technologies will be facilitated by technical presentations, handbooks, and data exchange programs.

Value: This project will provide implementation guidance, in the form of a suitability matrix, to provide a means of gauging the impact of a technology. The cooperative nature of this effort also allows for the capture of technologies developed by both the private and government sectors. The results of this program will be suitable for distribution on a broad basis to the user community. At the same time the program will focus feasibility studies onto a limited number of suitable technologies rather than the all-encompassing actions currently executed. This improved efficiency will lead to quicker and less costly restoration actions.

Accomplishments to Date: Two initial technology evaluations (soil composting for energetic contamination and pump and treat technology for groundwater) have been conducted and a final report on each issued. These efforts established a common reporting format in addition to identifying critical criteria for technology applications and acceptance.

Future Plans/Milestones:	
Identify additional technologies for assessments	June 1994
Complete certification and regulatory acceptance study for initial technology analyses	September 1994
Data exchange and transfer activities	As Required
Technology assessments	As Required

Available Documentation:

Technology Application Analysis, **Windrow Composting of Explosives-Contaminated Soil At Umatilla Army Depot Activity,** September 1993

Cost Analyses

Point of Contact: Theodore E. Ruff (410) 671-1564, DSN 584-1564

Purpose: To collect and evaluate cost data for technologies in development or for technologies recently implemented.

Problem Addressed: As new technologies are developed and implemented, accurate cost data is required to support the evaluation process to select the best alternative for a given application.

Value: This project will provide support for the development and implementation of pollution control, prevention, and restoration technologies. Cost analyses will be conducted to aid in technology selection, technology acceptance, and implementation.

Accomplishments to Date: Cost analyses were completed during 1991 for the following:

a. paint waste incineration strategies at Army depots
b. full-scale operation of air stripping of volatile organic compounds (VOCs) from groundwater
c. the feasibility of composting waste nitrocellose fines.

A cost analysis was completed in 1992 to provide an economic analysis for incineration of explosives-contaminated soil and an evaluation of the general incineration process design. A cost analysis was done in FY92 to prepare an economic analysis and review of the Site Characterization and Analysis Penetrometer System (SCAPS) technology. SCAPS technology was then compared to conventional monitoring wells for detection of petroleum, oil, and lubricant contamination of soil and groundwater.

Future Plans/Milestones:	
Hot gas decontamination of explosives-contaminated equipment Cost Analysis (CA)	September 1994
Mixed windrow composting CA	January 1995
Explosives-contaminated soil biodegradation in a slurry reactor CA	June 1995
Nondestructive decontamination of chemical agent-contaminated structures CA	September 1995
Solar detoxification of contaminated soil technology CA	September 1995
Use of propellants as supplemental fuels CA	June 1996

Available Documentation:

Technical report, **Process and Economic Feasibility of Using Composting Technology to Treat Waste Nitrocellulose Fines,** USATHAMA Report CETHA-TE-CR-91012, March 1991.

Technical report, **Technical and Economic Evaluation of Air Stripping for Volatile Organic Compound (VOC) Removal from Contaminated Groundwater at Selected Army Sites,** USATHAMA Report CETHA-TE-CR-91023, July 1991.

Technical report, **Cost Analysis of Paint Waste Incineration Technology at U.S. Army Depots,** USATHAMA Report CETHA-TE-CR-91050, October 1991.

Technical report, **Incineration of Explosives Contaminated Soil Cost Analysis and General Incineration Process Design,** USATHAMA Report CETHA-TS-CR-92048, July 1992.

Development of a Subsurface Gas Sampling System

Point of Contact: George E. Robitaille (410) 671-1576, DSN 584-1576

Purpose: Develop a method to quantify subsurface gas measurements.

Problem Addressed: Currently, subsurface gas measurements are done with a grab technique in which samples are collected and then transported offsite to a laboratory for analysis. This procedure is both costly and time consuming.

Value: This technique can do quantitative and qualitative field analysis of subsurface gas contaminants. The capability to do real-time analysis in the field would reduce the time and costs associated with the site characterization process.

Accomplishments to Date: Eight prototype subsurface sampling units and two surface interface modules have been manufactured. Laboratory testing has shown that this system will respond uniformly whether deployed in soil or water. The prototype was successfully deployed with the Site Characterization Cone Penetrometer System. Field tests duplicated the laboratory findings and identified areas that would require additional research. Alternative polymer membranes have been identified that will improve handling problems in the field and the efficiency of contaminant transport.

Future Plans/Milestones:	
Design and fabricate alternative polymer membrane cell (TerraTrog)	April 1994
Complete laboratory evaluation of alternative TerraTrog membrane holder	June 1994
Complete initial field testing	November 1994
Make modifications for future application with SCAPS	December 1994

Available Documentation:

Technical article, **A Soil Gas Sampler Implant for Monitoring Dump Site Subsurface Hazardous Fluids**, D. P. Lucero, *Hazardous Materials Control,* September/October 1990.

Technical paper, **Quantitative Soil Gas Sampler Implant for Monitoring Dump Site Subsurface Hazardous Fluids**, Proceedings of the Second International Symposium on Field Screening Methods for Hazardous Wastes and Toxic Chemicals, February 1991.

Technical article, **Quantitative In-Situ Soil Gas Sampling**, Mr. George Robitaille, *USATHAMA Environmental Update*, November 1992.

Technical paper, **On Site In-Situ Groundwater Well Analysis Using a Gas Sampling Implant and The Viking Transportable GC/MS System**, Proceedings of the 19th ADPA Environmental Symposium, Albuquerque, NM, March 1993.

Direct Sampling Mass Spectrometry

Point of Contact: George E. Robitaille (410) 671-1576, DSN 584-1576

Purpose: To develop quicker analytical turnaround times using mass spectrometry techniques.

Problem Addressed: In order to analyze water and soil samples with a high degree of certainty, mass spectrometry techniques are routinely used. Normal analytical times range from approximately 30 minutes to 1 hour. The ion trap mass spectrometer (ITMS) will allow the user to screen a sample for volatiles or semivolatiles and have results in 2 minutes or less. An ITMS is also being tested to see if interferences from multi-component samples can be eliminated.

Value: ITMS, when used as a laboratory tool, can reduce the time it takes to get accurate analytical results and increase the number of analytical samples analyzed by any laboratory. As a field tool, ITMS can reduce the expense of sending samples to a laboratory by indicating what samples are contaminated on a near real-time basis.

Accomplishments to Date: Studies using tetrachloroethylene, benzene, and trichloroethylene singularly and in mixtures have shown levels of quantitation below 5 ppb with analysis times of less than 2 minutes. Purge techniques using a sorbent cartridge and thermal desorber have helped in the analysis of less volatile compounds. ITMS has proved to be effective in minimizing quantitation interferences in volatile samples. Work to investigate semivolatile interference reduction is ongoing. The ITMS has been successfully field tested at several Department of Energy sites.

Future Plans/Milestones:	
Optimize thermal desorption technique for the determination of semivolatile organics	June 1994
Optimize solid phase extraction technique for the determination of semivolatile organics	September 1994
Complete special technologies survey	September 1994
Report on technology assessment and/or screening method	December 1994

Available Documentation:

Technical report, **Rapid Environmental Organic Analysis by Direct Sampling Glow Discharge Mass Spectrometry and Ion Trap Mass Spectrometry: Summary of Pilot Studies**, USATHAMA Report, CETHA-TE-CR 90029, December 1989.

Technical report, **Direct Sampling Ion Trap Spectrometry**, *Spectroscopy Magazine,* April 1993.

DOD National Environmental Technology Demonstration Program for Explosives and Heavy Metals Contamination

Point of Contact: Theodore E. Ruff (410) 671-1564, DSN 584-1564

Purpose: To provide locations for comparative demonstration and evaluation of innovative environmental cleanup technologies, so that cost-effective technologies can move from the research stage to full-scale use. This program is an inter-agency effort among the Air Force, Army, Navy, and the Environmental Protection Agency (EPA).

In order to fulfill its purpose this program will establish locations at federal facilities where Government and private innovative remediation technologies can be demonstrated. Each of the services has its own contaminant focus area as follows:

a. solvents for the Air Force
b. explosives and heavy metals for the Army
c. petroleum based lubricants (POLs) for the Navy.

The EPA is establishing the National Center for Integrated Bioremediation Research and Development . This organization is establishing, with input from the user and regulatory communities, uniform protocol, Quality Assurance/Quality Control (QA/QC), and reporting requirements.

Problem Addressed: One of the impediments to introducing cost-effective innovative cleanup technologies into common use at federal facilities is user and regulatory acceptance. There are no "permanent" test locations where technologies can be evaluated under similar conditions to determine technical feasibility and cost effectiveness. As a result, acceptance by users and regulators comes slowly. Also, while technology demonstrations are performed, there is no uniformity to the data requirements, QA/QC, or reporting formats. This lack of uniformity increases the difficulty users and regulators alike have in determining the applicability of a technology to a remedial solution.

Another problem addressed by the Department of Defense (DOD) National Technology Demonstration Program is the difficulty private industry has developing innovative cleanup technologies. Currently, private interests have difficulty testing innovative technology for environmental problems because of environmental liability issues.

This program provides locations where the Government can provide the contaminated media and real estate to perform demonstrations. The private firm demonstrating the technology can be freed from environmental liability constraints.

Accomplishments to Date: Volunteer Army Ammunition Plant (VAAP) has been selected as the first location for the DOD National Technology Demonstration Program for Explosives Contamination. Other areas are currently being evaluated for selection of the second location.

The VAAP management plan, site and safety plans, and data acquisition management plans have been initiated.

Efforts have been initiated to determine user and regulator requirements for demonstration protocols, QA/QC, and reporting.

Future Plans/Milestones:	
Select second explosive and heavy metals test location	July 1994
Complete detailed site characterization at VAAP	August 1994
Complete test location preparation	November 1994
Initiate first demonstration	October 1994

Available Documentation: None

Evaluation of Ultraviolet Oxidation (UV/Ox) Methods for the Remediation of Explosives-Contaminated Groundwater

Point of Contact: Richard H. O'Donnell (410) 671-1589, DSN 584-1589

Purpose: To determine the technical and economic applicability of UV/Ox technology for the removal of explosives contamination from groundwater.

Problem Addressed: Numerous U.S. Army installations have sites containing groundwater that has been contaminated with energetic materials and wastes. The primary method of removing these materials from water involves the use of granular activated carbon (GAC). GAC only concentrates the contamination on a filter bed and does not destroy the contaminants. GAC operations can become cost-prohibitive depending on the alternatives available for contaminant disposition. Processes that are more cost effective than GAC and result in the immediate destruction of the contaminants are sought.

Value: Significant cost savings may be realized when groundwater is treated with photocatalytic methods. UV/Ox technology provides a single-step process that results in the destruction of contaminants and requires minimal expenditure of resources. A demonstration of UV/Ox technology will document the technical and cost effectiveness of this technology.

Accomplishments to Date: An assessment of commercial equipment and U.S. Army developmental equipment has been completed. A number of different equipment designs have been identified that are based on UV/Ox technology and are effective at treating explosives-contaminated groundwater. Site selection for a field demonstration has been completed. Savanna Army Depot Activity has been selected as the site for this demonstration.

Future Plans/Milestones:	
Select commercial equipment	April 1994
Install pilot-scale equipment	May 1994
Demonstrate technology	June 1994
Final report	September 1994
Technology transfer package	February 1995

Available Documentation: None

Explosives Soil Slurry Bioreactor

Point of Contact: Mark L. Hampton (410) 671-1559, DSN 584-1559

Purpose: To develop soil slurry reactor technology for bioremediation of soils contaminated with explosives.

Problem Addressed: A number of U.S. Army installations have sites with explosive-contaminated soils and sediments. Although incineration systems have been demonstrated as an effective treatment technology, the treatment costs are high. At some installations, because of the soil composition and availability of amendments, use of a slurry bioreactor may be more appropriate than composting.

Value: The use of a soil slurry bioreactor offers another bioremediation technology that has the potential to effectively degrade explosives in soil and sediment at a significantly lower cost. The residual material could be readily revegetated as part of the site restoration effort.

Accomplishments to Date: Bench-scale studies using soils contaminated with trinitrotoluene (TNT) from the Joliet Army Ammunition Plant (JAAP) demonstrated the feasibility of effectively biologically degrading TNT using a soil slurry reactor. The bench-scale studies were conducted in various reactor configurations to include a 10-liter slurry reactor, sequencing batch reactors, and a novel white rot fungus reactor. Reductions in TNT concentrations were encouraging. Bench-scale results indicated the need for a pilot-scale demonstration using soil slurry-sequencing batch reactors (SS-SBR) to determine the feasibility of this new innovative technology. Joliet Army Ammunition Plant has been selected for the pilot-scale field demonstration.

Future Plans/Milestones:

Initiate SS-SBR pilot-scale testing	March 1994
Completion of SS-SBR pilot-scale testing	November 1994
SS-SBR pilot-scale final report completed	March 1995
Cost analysis report	September 1995
SS-SBR optimization study completion/final report	November 1995
Finalize procurement/fabrication guidance	March 1996
Provide operator training	As required

Available Documentation:

Technical report, **Feasibility of Biodegrading TNT Contaminated Soils in a Slurry Reactor**, USATHAMA Report CETHA-TE-CR-90062, June 1990.

Technical report, **Evaluation of the Feasibility of Biodegrading Explosives-Contaminated Soils and Groundwater at Newport Army Ammunition Plant (NAAP)**, USATHAMA Report CETHA-TS-CR-9200, June 1991.

Extraction and Chromatographic Development of Selected Organophosphorus Compounds from Soil and Aqueous Media

Point of Contact: Tony R. Perry (410) 671-1572, DSN 584-1572

Purpose: The primary objective is to develop and evaluate a potential fate model to assess whether alkylmethylphosphonates arising from chemical surety material (CSM) and non-CSM related sources have been present. It is also necessary to determine when the chemicals were introduced into the environment. The secondary objective of this program is to develop and evaluate a potential fate model of thiodiglycol in soil to determine the degradation kinetics factor.

Problem Addressed: The U.S. Army Environmental Center (USAEC), has been tasked to identify and clean up contaminants that have been found on or near Army installations. Some of these contaminants can be attributed to past or ongoing manufacturing, testing, storage, and disposal operations involving munitions that contain chemical warfare agents. As a result of these operations, soil and groundwater may have been contaminated by chemical warfare agents and, subsequently, by their degradation products.

The USAEC, through the Installation Restoration and Base Closure programs, has been assigned the mission of assessing the extent of any contamination so that cleanup, if it is necessary, can take place. Current analytical methodology used to assess soil and groundwater contamination attributed to breakdown products from chemical warfare agents is not adequate to meet project needs. Without adequate assessment of possible contamination sites, corrective action cannot be properly implemented.

Value: The results of this task will help installations identify specific chemical surety breakdown products.

Accomplishments to Date: The University of Delaware has developed novel methods for the simultaneous determination of pinacolyl methylphosphonic acid (PMPA), isopropyl methylphosphonic acid (IMPA), ethyl methylphosphonic acid (EMPA), methylphosphonic acid (MPA), dimethyl methylphosphonate (DMMP), diethyl methylphosphonate (DEMP), diisopropyl methylphosphonate (DIMP), glyphosate, dequest 2010, dequest 2041, and dequest 2051 in water. The university has also extended this technique to include a variety of characterized soils.

Because of the aforementioned work, Method AAA9 (for methylphosphonic compounds) is no longer used by the USAEC. The following two methods supersede it:

a. PMPA, IMPA, EMPA, and MPA in water
b. PMPA, IMPA, EMPA, and MPA in soil.

Future Plans/Milestones:	
Determine the rate (kinetics) of conversion of the above compounds and the original compounds (IMPA, PMPA, and EMPA) to MPA	January 1995
Develop a potential fate model of thiodiglycol (TDG) and what factors influence degradation	January 1995

Available Documentation:

Technical paper, **A New Ion Chromatographic Method for Alkyl Methylphosphonates Using A Solvent Compatible Column**, Posted Session of the American Chemical Society's 204th National Meeting, August 1992.

Technical report, **Extraction and Chromatic Development of Selected Organophosphorus Compounds from Soil and Aqueous Media**, U.S. Army Report TCN91429, October 1993.

Field Portable Instrumentation – X-Ray Fluorescence

Point of Contact: Martin H. Stutz (410) 671-1568, DSN 584-1568

Purpose: To determine the availability and effectiveness of field-portable instrumentation for the determination of metals: Cu, As, Hg, and Pb. The instrumental detection limits are in the 4 to 42 ppm range for metals in water and the 10 to 60 ppm range for metals in soil.

Problem Addressed: Current methods for the analysis of metals require that samples be sent to the lab for analysis.

Value: This system can be used in the field and achieves reasonable quantitative results for wet soil and water contaminated in the 100 to 300 ppm range. Having the analysis done in the field saves time and shipping costs.

Accomplishments to Date: Laboratory and bench testing was conducted at Oak Ridge National Laboratory. Trial field tests were conducted at the Rocky Mountain Arsenal. Various instrument and detector configurations were examined. The instrument that best meets the requirements of fieldability, selectivity, and sensitivity was selected and evaluated for performance in the screening for hazardous waste metals in soils.

Different equipment will be tested at installation restoration sites for data collection and comparison purposes.

Future Plans/Milestones:	
Completion of final report	September 1994

Available Documentation: None

Field Portable Mass Spectrometry

Point of Contact: George E. Robitaille (410) 671-1576, DSN 584-1576

Purpose: To develop a field portable mass spectrometer.

Problem Addressed: In order to analyze water and soil samples with a high degree of certainty, mass spec techniques are routinely used. The normal time it takes for a laboratory to analyze data ranges from to 40 days after receipt of a sample. A fieldable, or field portable, mass spectrometer (MS) is being tested to see if sample results can be correlated in 30 minutes or less.

Value: A field portable MS can reduce the time it takes to get accurate analytical results and increase the number of analytical samples analyzed. As a field tool, the expense of sending samples to a laboratory is reduced because the extent of site contamination is identified on a near real-time basis.

Accomplishments To Date: Laboratory studies using compound mixtures have shown levels of quantitation below 10 ppb with turnaround times of less than 30 minutes.

Field tests have been completed at Fort Devens, MA with a Bruker gas chromatograph/ mass spectograph (GC/MS), and a final report that correlates the results of the field demonstration with traditional methods of analysis is available.

Several field tests have been completed at Savannah River Station with an ion trap mass spectrometer. The results were very promising, and several units have been transitioned into the field for routine analysis.

The principal investigators for the ion trap mass spectrometer (ITMS) and GC/MS systems gave presentations at the U.S. Army Environmental Center on their respective instrument capabilities and limitations.

Future Plans/Milestones:	
Evaluate field ITMS in conjunction with the Site Characterization and Analysis Penetrometer System (SCAPS)	February 1994
Conduct a field demonstration of the Bruker GC/MS for the characterization of an explosives-contaminated site	September 1994
Pursue regulatory acceptance of these technologies	September 1994

Available Documentation: None

Field Sample Preparation

Point of Contact: Martin H. Stutz (410) 671-1568, DSN 584-1568

Purpose: To develop field sample preparation techniques for common environmental contaminants.

Problem Addressed: Presently, handling groundwater samples and soil samples requires the collection of an appropriate sample, addition of the proper preservative, and shipment back to an environmental laboratory for the required analyses. Recent research and development programs run by the Army have stressed the importance of field analytical instrumentation as a viable alternative to shipping samples to an environmental laboratory. The samples, however, often have to be prepared for analysis using the same techniques found in the laboratory.

Value: Proper field sample preparation can eliminate the inherent loss of compounds that occurs as they are prepared for shipment and later analysis. Procedures that are more efficient, cost efficient, and timely need to be implemented so that field teams have an indication of what samples are contaminated on a near real-time basis.

Accomplishments to Date: New sample containers for collecting volatiles have been developed and manufactured. Technology was demonstrated at one site. Additional comparisons demonstrated that the recovery of volatiles is enhanced when compared to conventional methodology. A way to prepare a performance evaluation sample has been demonstrated. Follow-up efforts will be conducted at additional sites to demonstrate the applicability of the methodology. Additional efforts will focus on a demonstration of procedures to enhance the preservation of volatile organic compounds (VOC)-contaminated soil and to establish the efficiency of a performance evaluation sample for soil volatiles.

Future Plans/Milestones:

Assess effects of chemical additives on the inhibition of biodegradation of volatiles	June 1994
Assessment of ruggedness of vapor fortified performance evaluation samples for volatiles	July 1994
Assess sample integrity of volatile samples shipped in core liners	September 1995

Available Documentation:

Technical report, **Rapid Environmental Organic Analysis by Direct Sampling Glow Discharge Mass Spectrometry and Ion Trap Mass Spectrometry: Summary of Pilot Studies,** USATHAMA Report No. CETHA-TE-CR 90029.

Technical report, **Aqueous Extraction - Headspace Gas Chromatographic Method for Determination of Volatile Organic Compounds in Soils**, CRREL Special Report 92-6.

Technical article, **Comparison of Sampling Methods for Trichloroethylene in Vadose Zone Soils**. A.D. Hewitt. Accepted for publication in Journal AOAC.

Technical article, **Preparation of Spiked Soils for Volatile Organic Compound Analysis by Vapor Fortification**. A.D. Hewitt. Accepted for publication in Journal AOAC.

Technical report, **Feasibility Study of Vapor Fortification Preparation of Volatile Organic Compound Performance Soil Samples**, CRREL Special Report 93-5.

Technical report, **Concentration Stability of Four Volatile Organic Compounds in Isolated Soil Subsamples**, CRREL Special Report (In Press).

Technical report, **Losses of Trichloroethylene from Soil During Sample Collection, Storage and Sample Handling**, CRREL Special Report (In Press).

Technical report, **Determination of Two Chlorinated Volatile Organic Compounds in Soils by Headspace Gas Chromatography and Purge-and-Trap Gas Chromatography Mass Spectrometry**. A.D. Hewitt, P.H. Miyares and R.S. Sletten. Hydrocarbon Contaminated Soils, Volume III, Lewis Publishers, Boca Raton, 1993.

Hazardous Waste Minimization Technology Transfer/ Implementation Support

Point of Contact: Richard L. Eichholtz (410) 671-1565, DSN 584-1565

Purpose: To provide U.S. Army Depot Systems Command (DESCOM) facilities with support for technology transfer and implementation of aluminum ion vapor deposition (AIVD), electrodialysis of plating solutions, and the filtration of paint-stripping baths.

Problem Addressed: Plating and paint removal operations are a significant source of hazardous waste generation during the overhaul of tactical equipment at depot installations. The implementation of AIVD, electrodialysis, and paint bath filtration will reduce the amount of waste generated and may reduce operational costs.

Value: Demonstration testing of the AIVD process has shown that the process generates virtually no hazardous waste. Additionally, the process can replace cadmium electroplating. Cadmium is a carcinogen, and the process requires the use of toxic solvents. The electrodialysis system can reclaim spent plating solutions for subsequent reuse. The useful life of a paint-stripping solution can be extended drastically by filtering paint residue out of the stripping bath.

Accomplishments to Date: AIVD was successfully demonstrated at Anniston Army Depot. An electrodialysis system has been evaluated at Corpus Christi Army Depot. Letterkenny Army Depot has implemented and tested a filtration unit on an operational paint-stripping bath. Because the current delivery order contract expired and project funding by Tobyhanna Army Depot was delayed, only design /installation specifications, economic analysis, and operating/maintenance procedures will be delivered.

Future Plans/Milestones:

Initial visits to installations requesting support	November 1993
Present recommendations for implementation of the AIVD, electrodialysis, and filtration processes	November 1993

Available Documentation:

Technical report, **Evaluation of Aluminum Ion Vapor Deposition as a Replacement for Cadmium Electroplating at Anniston Army Depot**, USATHAMA Report CETHA-TS-CR-91054.

Technical report, **Evaluation of A Particulate Filtration System for an Alkaline Paint Stripper At Letterkenny Army Depot**, USATHAMA Report CETHA-TS-CR-91033, August 1991.

Technical report, **Evaluation of Electrodialysis for Chromic Acid Recovery and Purification at Corpus Christi Army Depot**, USATHAMA Report CETHA-TS-CR-91032, September 1991.

Hot Gas Decontamination of Explosives-Contaminated Equipment

Point of Contact: Erik B. Hangeland (410) 671-1556, DSN 584-1556

Problem Addressed: The Army has two types of explosive contaminated metal that require decontamination: process equipment and exploded ordnance scrap. Prior to excessing the process equipment and the ordnance scrap, the metal must be decontaminated and certified contaminant free (5X). In many cases, the process equipment may be inaccessible internally to allow adequate decontamination and sampling for certification purposes. Hot gas technology is being developed to allow cost-effective decontamination of internal and external surfaces. This process is being targeted in particular on contaminated process equipment that requires decontamination for reuse.

Value: The results of this effort will provide Army ammunition plant and depot operators with a non-destructive and environmentally acceptable alternative to Open Burning/Open Detonation (OB/OD). It also provides an alternative to destructive incineration methods used in some demilitarization and decontamination missions. Hawthorne Army Ammunition Plant (HWAAP) intends to implement this technology as a supplement to existing demilitarization operations.

Accomplishments to Date: Based on conceptual and laboratory evaluations, a hot gas process that uses burner exhaust gases involving in situ decontamination of structures has been demonstrated. A separate demonstration program for explosives-contaminated equipment was started in FY88. An initial demonstration test program on trinitrotoluene (TNT) contaminated process equipment (sewer lines, pumps, etc.) was successfully completed in August 1989 at HWAAP. The HWAAP system has been redesigned based upon recommendations from the demonstration.

Currently, the system data base is being expanded to include additional explosive combinations, mixtures of TNT and cyclotrimethylenetrinitramine (RDX), ammonium picrate, and additional explosives-contaminated items from the HWAAP demil inventory. Appropriate safety and operational data are being collected. Upon completion of the optimization process, the system will be put into full-scale use at HWAAP as part of their demilitarization operations.

The milestones that follow reflect the completion of currently planned activities. As data is collected and analyzed, decisions will be made in conjunction with the safety community (U.S. Army Defense Ammuniction Center and School) about the suitability of this technology for various missions and the need for additional data.

Future Plans/Milestones:	
Demonstration test to expand data base completed	September 1994
Generic design package completed	September 1994
Technology transfer package	December 1994

Available Documentation:

Technical report, **Development of Novel Decontamination and Inerting Techniques for Explosives-Contaminated Facilities, Phase I - Identification and Evaluation of Novel Decontamination Concepts**, USATHAMA Report DRXTH-TE-CR-83211, July 1983.

Technical report, **Development of Novel Decontamination and Inerting Techniques for Explosive-Contaminated Facilities, Laboratory Evaluation of Concepts, Phase II - Laboratory Evaluation of Novel Explosives Decontamination Concepts**, USATHAMA Report AMXTH-TE-TR-85009, March 1985.

Technical report, **Design Support for a Hot Gas Decontamination System for Explosives-Contaminated Buildings**, Maumee Research and Engineering, April 1986.

Technical report, **Pilot Plant Testing of Caustic Spray/Hot Gas Building Decontamination Process**, USATHAMA Report AMXTH-TE-CR-87112, August 1987.

Technical report, **Task Order - 2, Pilot Test of Hot Gas Decontamination of Explosives-Contaminated Equipment at Hawthorne Army Ammunition Plant (HWAAP) Hawthorne, Nevada,** USAEC Report CETHA-TE-CR-90036, June 1990.

Low Loss Infrared Transmitting Fibers

Point of Contact: George E. Robitaille (410) 671-1576, DSN 584-1576

Purpose: To do the research and development necessary to produce low loss chalcogenide fibers that transmit in the 3-12 μm region.

Problem Addressed: Currently available fiber optics for the infrared region are limited in their useful length because of the impurities contributed during production. This shortcoming limits the technologies (e.g., Raman and infrared spectroscopy) that can be used with the cone penetrometer system.

Value: Reduced impurity levels in the fibers would increase the efficiency of the transmitted signal and therefore improve the detection levels of the associated analytical equipment.

Accomplishments to Date: Chalcogenide fibers have been produced in 30-meter lengths, which are currently not available commercially.

Future Plans/ Milestones:	
Design infrared (IR) reflectance probe	March 1994
Interface currently available low loss IR cable	June 1994
Evaluate IR reflectance detection limits for benzene, toluene, ethylbenzene and xylene (BTEX) compounds	June 1994
Complete materials purification processes to ensure that losses are less than 1 dB/m	July 1994
Complete glass cladding fiberization process with optical losses of less than 1 dB/m	August 1994
Produce low loss IR transmitting fiber with tensile strength greater than 50 psi	August 1994
Fabrication/evaluation of prototype IR sensor system	September 1994
Analysis and characteristics of core and cladding glasses	September 1994
Fabricate cables for use in fiber optic chemical sensors	September 1994

Available Documentation:

Technical paper, **Effect of Scattering Centers on the Optical Loss of Chalcogenide Glass Fibers in the Infrared**, Proceedings of the 95th Annual American Ceramic Society Meeting, Cincinnati, OH, April 1993.

Low Temperature Thermal Treatability Study

Point of Contact: Edward G. Engbert (410) 671-1575, DSN 584-1575

Purpose: To evaluate the capability of the U.S. Army Waterways Experiment Station (WES) to conduct treatability studies using low temperature thermal desorption technology on field samples contaminated with volatile and semi-volatile contaminants.

Problem Addressed: As a result of past solvent and fuel handling practices, soils at a number of Army installations are contaminated with a number of organic compounds. Without treatment, these compounds can be expected to eventually migrate into and contaminate groundwater. Low temperature thermal treatment is designed to remove volatile and semi-volatile organic constituents from soil in situations where in situ volatilization is not suitable. The following low temperature thermal desorption processes are commercially available: the thermal screw design, the rotary dryer design, the asphalt plant aggregate design, and the conveyor furnace design.

Value: Landfill and incineration are alternatives that would otherwise have to be employed if in situ volatilization was not applicable. Low temperature thermal treatment can reduce treatment costs by as much as $200/ton compared to these other alternatives.

Accomplishments to Date: A treatability test procedure for prescreening soils has been established at the WES. Consultation and sample testing will be conducted at WES on a cost reimbursable basis. The testing process is being evaluated closely in its first application, and refinements will be made as it is prepared to serve as a routine technology transfer mechanism. Contaminated soil samples were collected from a disposal site at the Letterkenny Army Depot (LEAD) in February 1993 and sent to WES for testing and evaluation.

Future Plans/Milestones:	
Collect second soil samples from LEAD	February 1994
Test samples at WES	March 1994
Final report	May 1994

Available Documentation:

Technical report, Task 11, **Pilot Investigation of Low Temperature Thermal Stripping of Volatile Organic Compounds for Soil**, USATHAMA Report AMXTH-TE-TR-86074, June 1986.

Technical report, **Low Temperature Thermal Desorption Processes for the Remediation of Soils Contaminated with Solvents, Hydrocarbons, and Petroleum Products**, USAEC Report CETHA-TS-CR-93042, February 1993.

Nondestructive Decontamination of Chemical Agent Contaminated Facilities

Point of Contact: Martin H. Stutz (410) 671-1568, DSN 584-1568

Objective: To develop an innovative, nondestructive technology to decontaminate Army facilities and equipment contaminated by chemical agents or energetic materials. The decontamination would enable the Army to reuse or dispose of the equipment as excess.

Approach: The Army owns and operates ammunition plants, arsenals, and depots involved in the manufacture, processing, loading, and storage of chemical agents, pyrotechnics, explosives, and propellants. These operations have resulted in the contamination of buildings and a variety of processing and handling equipment. Many facilities are in an inactive or standby status and are candidates for excessing actions. In some cases, contaminated buildings have significant reuse potential for conversion to other operational uses.

Current decontamination standards require dismantlement, in a controlled atmosphere, followed by incineration. The technology being developed in this project has the potential to decontaminate facilities and equipment in a cost effective and environmentally acceptable manner without destroying structural integrity.

Value: This project will provide a safe and effective means of either decontaminating a structure for future reuse or rendering a building safe for demolition. Additionally, this effort will help establish analytically based decontamination standards as opposed to the current operationally based standards.

Accomplishments to Date: A demonstration of the Hot Gas Decontamination System (HGDS) for chemical agent decontamination will be conducted at Rocky Mountain Arsenal, Building 537. The site has been characterized, and system construction has been completed.

Future Plans/Milestones:	
Chemical HGDS challenge testing	February 1994
Chemical HGDS demonstration	February 1994
Data analysis	May 1994
Final report	July 1994

Available Documentation:

Technical report, **Development of Novel Decontamination Techniques for Chemical Agents (GB,VX,HD) Contaminated Facilities, Phase I - Identification and Evaluation of Novel Decontamination Concepts,** USATHAMA Report DRXTH-TE-CR-83208, February 1983.

Technical report, **Development of Novel Decontamination and Inerting Techniques for Explosives-Contaminated Facilities, Phase I - Identification and Evaluation of Novel Decontamination Concepts,** USATHAMA Report DRXTH-TE-CR-83211, July 1983.

Technical report, **Development of Novel Decontamination and Inerting Techniques for Explosives-Contaminated Facilities, Laboratory Evaluation of Concepts, Phase II - Laboratory Evaluation of Novel Explosives Decontamination Concepts,** USATHAMA Report AMXTH-TE-TR-85009, March 1985.

Technical report, **Development of Novel Decontamination Techniques For Chemical Agents (GB, VX, HD) Contaminated Facilities, Phase II - Laboratory Evaluation of Novel Agent Decontamination Concepts,** USATHAMA Report AMXTH-TE-TR-85012, June 1985.

Pilot Demonstration of TNT Red Water Treatment Technology

Point of Contact: Darlene F. Bader (410) 671-1573, DSN 584-1573

Purpose: To prepare test and safety plans and to determine the conceptual design and layout for pilot-scale testing of circulating bed combustion and wet air oxidation.

Problem Addressed: The production of trinitrotoluene (TNT), the major component of most of the Department of Defense's explosives, generates a listed hazardous waste stream (KO47) called red water. There are four Army Ammunition Plants: Radford, Joliet, Newport, and Volunteer, that are capable of producing TNT. However, TNT has not been produced by these facilities during recent years. In order to increase the Army's readiness to produce TNT, an acceptable method of treating red water must be developed.

Value: This effort will demonstrate red water treatment technology and could result in the capability to reduce previous contamination caused by red water. An effective treatment technology will also provide a means of complying with environmental regulation. An effective treatment technology will meet congressional concerns expressed during the FY92 appropriations process. Those concerns focused on the need for a suitable method of treating the red water waste stream from TNT production before full-scale TNT production is restarted within the United States.

Accomplishments to Date: Full pilot-scale demonstrations of the circulating bed combustion system have been successfully completed on liquid wastes, and prototype systems could be used to verify circulating bed combustion's effectiveness in treating red water. The wet air oxidation process is currently in the exploratory development phase at the U.S. Army Construction Engineering Research Laboratory. An evaluation of the options for obtaining red water, required to complete tests and field evaluations, was completed in August 1993.

Future Plans/Milestones:	
Vendor search/selection	February 1994
Test equipment specification/design	March 1994
Identification of regulatory requirements	April 1994
Site support requirements and modifications	May 1994
Draft safety plan report	July 1994
Draft test plan report	August 1994
Final project report	August 1994

Available Documentation:

Technical report, **Technology Evaluation for Treatment/Disposal of TNT Red Water**, USATHAMA Report CETHA-TE-CR-90048, April 1990.

Technical report, **Evaluation of Six Options for Obtaining Red Water**, USAEC Report ENAEC-TS-CR-93105, August 1993.

Plasma Arc Technology

Point of Contact: Louis Kanaras DSN 584-1558, (410) 671-1558

Purpose: To evaluate the process capability of plasma arc technology for the ultimate destruction of hazardous item components, to verify slag suitability for regular landfill disposal and/or for use as a construction material, to identify potential hazards associated with the process emissions, and to develop qualified cost estimates for future use of the process on large scale operations.

Problem Addressed: The U.S. Army has a continuing need to develop better methods of disposing of environmentally hazardous military wastes. Substances of particular concern to the U.S. Army include organics, inorganics, heavy metals, and asbestos, which are toxic, carcinogenic, or both.

Much hazardous waste in the Department of Defense ultimately has to be disposed of in a hazardous waste landfill because the waste contains one or more hazardous substances even after it is treated by conventional technologies. An example of this type of waste is the residue from open burning of pyrotechnic manufacturing wastes. The residue would fail the Toxicity Characteristics Leaching Procedure test because of the high barium, lead, or chromium content.

Other problem Department of Defense (DOD) wastes are military munitions that currently have no documented demilitarization procedures, or military munitions that generate hazardous wastes upon demilitarization or attempts at demilitarization. Hazardous wastes that are complex mixtures or have an unknown composition, and hazardous wastes that require inordinate pre-processing and post-processing steps, are also problem wastes for conventional technologies.

Value: Plasma arc is a versatile treatment technology that can do the following:

a. handle complex waste streams
b. cause complete destruction of organic compounds
c. cause fusing of asbestos and vitrification of inorganics, rendering metals non-leachable in the slag
d. handle low level radioactive wastes and mixed wastes
e. eliminate dioxin and furan air emissions that are potential hazards in certain incineration efforts.

Plasma arc technology also significantly reduces future liability, especially for hazardous wastes containing heavy metals, asbestos, or radioactive components that are placed in sanitary landfills. With increasing community opposition to incinerators, and moratoriums being placed on the permitting of new incinerators, development of this technology could prove to be a valuable tool for remediation project managers.

Accomplishments To Date: In 1991, a feasibility study by U.S. Army Construction Engineering Research Laboratories (CERL) addressed the vitrification (glassification) of asbestos through plasma arc technology. The feasibility study was co-developed with the Georgia Institute for Technology through the Army Corps of Engineers Construction Productivity Advancement Research program.

In 1992, a joint study was conducted by the U.S. Armament Research, Development, and Engineering Center (ARDEC) and CERL to investigate the feasibility of using plasma arc pyrolysis to destroy and permanently render armament-related hazardous wastes inert. ARDEC codeveloped selection criteria and prioritized candidate waste streams. CERL evaluated the feasibility of destroying these wastes with plasma arc technology. The following five candidates were selected for initial feasibility tests:

a. thermal batteries from Seneca Army Depot, Romulus, NY
b. metal-contaminated soil from Picatinny Arsenal, Dover, NJ
c. incineration ash from Longhorne Army Ammunition Plant (LHAAP), Marshall, TX
d. reject pyrotechnic smoke assemblies from LHAAP
e. MK71 MOD 5 fuses.

Results of these tests have been reviewed by the U.S. Army Environmental Center (USAEC). The USAEC is also reviewing other tests being conducted at the Component Demilitarization Integration Facility in Butte, Montana. The Montana tests are associated with ARDEC and focus on pyrotechnic, smoke, and dye items that are designated for demilitarization. Testing conducted at Georgia Tech is associated with CERL and focuses on asbestos-containing construction wastes. A review of these test results will allow the USAEC to do the following:

a. avoid duplication of effort
b. obtain additional data to answer any data gaps
c. design the best possible test to further develop plasma arc technology.

This is a new start for the USAEC. Progress to date has included award of a contract for a pilot-scale demonstration to be conducted at the National Defense Center for Environmental Excellence (NDCEE) in Johnstown, PA. The operating contractor for NDCEE, Concurrent Technologies, has been identifying potential vendors of plasma arc equipment and sites that possess the equipment. The company is also ascertaining the feasibility of leasing equipment to the NDCEE and/or performing demonstrations at their facilities on the military complex wastes test candidates identified.

A decision about where the subject demonstration will be performed depends upon the availability of permits at the NDCEE and at the various vender facilities. In addition, the costs incurred leasing equipment and associated offgas handling equipment must be taken into consideration. Efforts are underway by Concurrent Technologies to identify five to seven hazardous waste candidates (at minimum). Three of the candidates will be selected for Phase I and Phase II testing.

Future Plans/Milestones:	
Final report (waste feed material)	August 1994
Final report (equipment selection)	September 1994
Initiate leasing of equipment	October 1994
Equipment and monitoring equipment installed	January 1995
Final test plan	January 1995
Permits	January 1995
Phase I test initiation	February 1995
Identification of necessary equipment modifications	May 1995
Equipment modification/shakedown testing complete	July 1995
Phase II test initiation	July 1995
Final report/final video	November 1995
Procurement/fabrication guidance	April 1996

Available Documentation: None

Rapid Field Characterization of Soil Samples for Hazardous Components by Fourier Transform Infrared Spectroscopy (FTIR)

Point of Contact: George E. Robitaille (410) 671-1576, DSN 584-1576

Purpose: To develop a method for rapid screening of samples for explosives and volatile and semivolatile compounds.

Problem Addressed: Current methods for the analysis of explosives, volatiles, and semivolatiles require transport of samples to a fixed laboratory. These analyses then require a lengthy extraction and cleanup process prior to analysis. This method allows for rapid analysis through the use of thermal desorption coupled with FTIR.

Value: The technique will allow for field analysis of a soil sample in approximately 10 minutes. The rapid analysis would permit field screening of samples and allow for rapid decision making on site. The ability to make near real time decisions would considerably reduce the time and costs associated with the site characterization process.

Accomplishments to Date: The qualitative and quantitative determination of as many as five analytes in a mixture has been successfully completed. The identification and quantification of explosives, mixtures of explosives, and explosives mixed with interfering compounds in spiked soil samples has been demonstrated. However, problems associated with the thermal desorption of larger samples must be resolved for this technology to be practical.

The spectral library was expanded to include 16 volatile compounds.

Future Plans/Milestones:	
Reconfigure equipment and process for thermally desorbing samples, to eliminate contamination of analytical equipment	June 1994
Broaden list of volatile and semivolatile compounds demonstrated	September 1994

Available Documentation:

Technical paper, **A Quantitative Method to Detect Explosives and Selected Semivolatiles in Soil Samples By Fourier Transform Infrared Spectroscopy**, Proceedings from 1992 JANNAF Safety and Environmental Subcommittee Meeting, 10-14 August 1992, Naval Post Graduate School, Monterey, CA.

Reuse of Propellants as Fuel Supplements

Point Of Contact: Louis Kanaras (410) 671-1558, DSN 584-1558

Purpose: To develop a technology for reusing waste propellants as a fuel oil supplement in industrial boilers.

Problem Addressed: Waste energetic materials are generated in significant quantities by the Army because off-specification materials are generated during production. Also, obsolete munitions and missiles are filled with these energetic materials. Current waste management practices involve either Open Burning/Open Detonation (OB/OD) or controlled incineration of these materials. Because of the potential environmental problems resulting from open burning or detonation of these materials, and the high costs associated with incineration, it is desirable to investigate other waste management options.

Value: Combustible energetic waste materials represent a significant source of energy. The demilitarization of rocket motors and missiles because of disarmament treaties will generate large amounts of waste propellants that will have to be disposed of. Therefore, it is important to consider the use of these waste materials as a fuel oil supplement for industrial boilers. This innovative technology will provide an alternative to OB/OD, a disposal technology that is rapidly losing favor with regulatory agencies. Preliminary investigations indicate that the potential for cost savings from using energetic waste materials as fuel supplements is significant when compared to disposal by incineration.

Accomplishments To Date: Since significant progress has been made in the development of a technology to use explosives as a supplemental fuel, its application to propellants was investigated. Initial laboratory studies determined it was not economical to prepare the supplemented fuel in the same way as is done for explosives. Explosives are solvated in toluene and mixed with fuel oil to form a solvent/explosive/fuel oil mixture. However, a study indicated it was more technically and economically feasible to use propellant/fuel oil slurries as supplemental fuels for industrial combustors. A hazard analysis has determined that there is no propagation potential with several types of propellants at the concentrations of interest.

The U.S. Army and the U.S. Navy have established a joint program to develop technology that would use waste propellants as a supplemental fuel. The pilot system was relocated to Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland on 2 June 93. After the Phase III tests with explosives used as a supplemental fuel are complete, a pilot-scale field demonstration will be conducted to determine the feasibility of using propellants as a supplemental fuel.

Future Plans/Milestones:	
Nozzle study	May 1994 - January 1995
Solubility study	May 1994 - February 1995
Evaluation of emission abatement technologies	May 1994 - March 1995
Pilot-scale demonstration of the use of propellants as supplemental fuels	January 1996 - July 1997
Cost analysis report/tech transfer package	November 1997
Finalize procurement/fabrication guidance	March 1998

Available Documentation:

Technical report, **Laboratory Tests to Determine the Chemical and Physical Characteristics of Propellant-Solvent-Fuel Oil Mixtures**, USATHAMA Report CETHA-TE-CR-90043, April 1990.

Technical report, **Phase I: Pilot Test to Determine the Feasibility of Using Explosives as Supplemental Fuel at Hawthorne Army Ammunition Plant (HWAAP) Hawthorne, Nevada**, USATHAMA Report CETHA-TE-CR-91006, 1991.

Technical report, **Technical and Economic Analyses to Assess the Feasibility of Using Propellant-No. 2 Fuel Oil Slurries as Supplemental Fuels**, USATHAMA Report, CETHA-TE-CR-91046, September 1991.

Technical report, **Zero Gap Testing of Propellant-No. 2 Fuel Oil Slurries**, USATHAMA Report, CETHA-TS-CR-92005, January 1992.

Reuse of Waste Explosives as a Supplemental Fuel

Point of Contact: Louis Kanaras (410) 671-1558, DSN 584-1558

Purpose: To develop a technology for reusing waste explosives as a fuel oil supplement in industrial boilers.

Problem Addressed: Waste energetic materials are generated in significant quantities by the U.S. Army because off-specification materials are generated during production. Also, obsolete munitions are filled with these energetic materials. Current waste management practices involve either Open Burning/Open Detonation (OB/OD) or controlled incineration of these materials. Because of the potential environmental problems resulting from open burning or detonation, and the high costs associated with incineration, it is desirable to investigate other waste management options.

Value: Combustible energetic waste materials represent a significant source of energy. It is, therefore, of value to consider the use of these waste materials as a fuel oil supplement for industrial boilers. Preliminary economic evaluations indicate that the potential for cost savings from using energetic waste materials as fuel supplements is significant when compared to disposal by incineration.

Accomplishments to Date: Safety and material handling aspects as well as emissions resulting from burning the materials as a fuel oil supplement have been evaluated. Hazards testing indicates that there should be no explosive hazards in burning explosive/fuel oil mixtures at the maximum explosive concentration ranges of interest.

Test results in 1988 with a combustor specially constructed to represent a boiler fire box were used to help design a more sophisticated pilot test system. The more sophisticated pilot-scale system consists of a commercially available boiler and a specially designed mixing/blending unit that is used to prepare the explosive supplemental fuel mixtures. The nozzle assembly of the standard industrial boiler was modified to allow injection of the explosives-supplemented fuel, and process controls were designed so the system can be operated remotely.

Phase I of the Pilot-Scale Demonstration at Hawthorne Army Ammunition Plant (HWAAP) was completed, and the results indicated that trinitrotoluene (TNT)-supplemented fuel can be safely and efficiently fired. The levels of nitrous oxides (NOx) increased when supplemented fuel was burned, but whether they exceed the allowable limits has not been determined. The Phase I tests also identified the need for some design modifications that will be implemented during Phase II of the Pilot Demonstration.

The pilot-scale system was moved in June 1993 to Indian Head Division, Naval Surface Warfare Center at Indian Head, Maryland for Phase II of the Pilot Demonstration. The U.S. Army and U.S. Navy will conduct a joint program to further develop the technology. A regulatory permit was obtained by Indian Head to conduct these tests in September 1993. The site safety plan approval was obtained in November 1993, and installation of the pilot test equipment was completed in November 1993. A representative from Day, Zimmerman, and Basil, who was the operating contractor at HWAAP and was originally tasked to upgrade the pilot test equipment (based upon Phase I tests at HWAAP and Phase II testin , visited Indian Head between 13-21 December 93. The representative helped start the equipment a d

provided New Equipment Training to Indian Head project personnel. Phase II will focus on increasing the concentration of explosives in the fuel mixture. After Phase II tests are completed with TNT and Composition B, Indian Head will initiate a program (Phase III) to investigate the wet grinding of energetics in fuel oil. Wet grinding may make necessary reductions in the size of the explosives in lieu of solvating them. A technical and economic evaluation will identify the optimum method of reusing waste explosives as a supplemental fuel.

Future Plans/Milestones:	
Emission monitoring equipment purchase and installation	February - July 1994
Develop baseline performance of boiler (fuel only)	March - September 1994
Solvated TNT/fuel oil supplemental fuel tests	July - November 1994
Solvated comp B/fuel oil supplemental fuel tests	July 1994 - January 1995
Nozzle study	May 1994 - January 1995
Solubility study	May 1994 - February 1995
Evaluate emission abatement technologies	May 1994 - March 1995
Report on phase II pilot scale demonstration	April 1995
Equipment/installation	October 1994 - June 1995
Wet-grinded TNT/fuel oil supplemental fuel tests	July 1995 - October 1995
Wet-grinded comp B/fuel oil supplemental fuel tests	July - December 1995
Report on phase III pilot scale demonstration	April 1996
Cost analysis	August 1996
Finalize procurement/fabrication guidance	November 1996

Available Documentation:

Technical report, **Testing to Determine Chemical Stability, Handling Characteristics, and Reactivity of Energetic-Fuel Mixtures**, USATHAMA Report AMXTH-TE-CR-87132, 1988.

Technical report, **Pilot-Scale Testing of a Fuel Oil-Explosives Cofiring Process for Recovering Energy from Waste Explosives**, USATHAMA Report AMXTH-TE-CR-88272, 1988.

Technical report, **Stationary Air Pollution Source Assessment No. 42-21-0515-88: Energetic Material/Fuel Oil Mixture Pilot Boiler**, U.S. Army Environmental Hygiene Agency, 1988.

Technical report, **Laboratory Tests to Determine the Chemical and Physical Characteristics of Propellant-Solvent-Fuel Oil Mixtures**, USATHAMA Report CETHA-TE-CR-90043, April 1990.

Technical report, **Phase I: Pilot Test to Determine the Feasibility of Using Explosives as Supplemental Fuel at Hawthorne Army Ammunition Plant (HWAAP) Hawthorne, Nevada**, USATHAMA Report CETHA-TE-CR-91006, 1991.

Sensor Development for the Cone Penetrometer System

Point of Contact: George E. Robitaille (410) 671-1576, DSN 584-1576

Purpose: To identify and develop sensor technologies that will enhance site screening capabilities of the cone penetrometer system.

Problem Addressed: Past operations at Army installations involving the manufacturing, handling, and disposal of hazardous materials have resulted in the contamination of soil and water. Current methods of contaminant evaluation are costly and time consuming, usually requiring transportation of samples to an off-site laboratory for subsequent analyses.

Value: Results of this effort will reduce the cost and expedite the process of site characterization through the implementation of in situ detection of environmental contamination.

Accomplishments To Date: Laboratory and field studies have been completed on a system that measures soil strength. Laboratory and field studies have been completed on a system that measures changes in soil electrical resistivity. Laboratory and field studies have been completed on a system for measuring the fluorescing properties of contaminants in soil.

Proof of theory has been completed on a trinitrotoluene (TNT) sensor and an in situ volatile organic compounds (VOC) sampler. Efforts to interface the TNT and the VOC technologies with the Superfund Consolidated Accomplishments Plan (SCAPS) are currently underway.

The petroleum oil and lubricant (POL) sensor has successfully completed five field demonstrations, with the most recent conducted at Sierra Army Ammunition Plant (SAAP). A workshop was held in Denver to evaluate potential chemical sensor technologies for the SCAPS. The POL sensor technology has been patented and a licensing agreement initiated.

Future Plans/Milestones:	
Complete fabrication of explosives sensing probe	January 1994
Conduct lab evaluation of nitrogen laser and tunable laser capabilities and limitations	February 1994
Conduct field evaluation of multi-port sampler	February 1994
Complete laboratory investigation of soil matrix effects on field portable TRPH analysis	March 1994
Complete lab evaluation of explosive sensor	May 1994
Complete field evaluation of explosive sensor	August 1994
Conduct tri-service field evaluation of LIF sensors	September 1994
Conduct field evaluation of on-site TRPH calibration in conjunction with tri-service LIF field test	September 1994

Available Documentation: None

Solar Detoxification of Soil

Point of Contact: Ronald P. Jackson (410) 671-1562, DSN 584-1562

Purpose: To develop a remediation system that will use solar energy to destroy organic contaminants desorbed from soil. The project is a collaborative effort between the U.S. Environmental Protection Agency's Risk Reduction Engineering Laboratory (RREL), the Department of Energy's National Renewable Energy Laboratory (NREL), and the U.S. Army Environmental Center (USAEC).

Problem Addressed: A remediation system employing solar energy may achieve equal or better cost and performance characteristics compared to conventional organic contaminant destruction technologies.

Value: The process is a doubly attractive method for soil remediation because the contaminants can be destroyed without increasing the demands on traditional sources of energy.

Accomplishments to Date: The USAEC and NREL have completed cost and performance feasibility studies. The RREL has created a "mini-pilot" system for laboratory testing. Final design of a pilot-scale system to be tested and evaluated at Sierra Army Depot (Herlong, CA) is ongoing.

Future Plans/Milestones:	
Final design specifications completed	July 1994
Fabricate and transport system to test site	July 1994 - July 1995
Conduct demonstration test	January - July 1995

Available Documentation:

Technical report, **Potential Feasibility of Using Solar Energy for Gas-Phase Destruction of Toxic Chemicals,** USATHAMA Report CETHA-TS-CR-92049, July 1992.

Technical report, **Preliminary System Design for Solar Detoxification of Solar; Interim Report 1,** USAEC Report ENAEC-TS-CR-93094, March 1993.

Technical report, **Preliminary System Design for Solar Detoxification of Solar; Interim Report 2,** AEC Report ENAEC-TS-CR-93095, March 1993.

Technical report, **Preliminary System Design for Solar Detoxification of Solar; Final Report, Task 1,** AEC Report ENAEC-TS-CR-93093, June 1993.

Solvent Substitution

Point of Contact: Edward G. Engbert (410) 671-1575, DSN 584-1575,

Purpose: To evaluate and demonstrate solvent substitution technologies employed at the Department of Energy's Oak Ridge National Laboratory (ORNL) that would be useful in Army depot maintenance.

Problem Addressed: Chlorinated solvents have been conventionally used throughout Army depots as cleaning agents in maintenance programs. These solvents have recently been implicated in health and environmental problems. Solvents such as trichlorotrifluoroethane (CFC-113) and methyl chloroform are considered ozone depleting substances and are scheduled to be banned by 1996 under regulations of the Montreal Protocol and its amendments. Solvents such as perchloroethylene and methylene chloride are suspected carcinogens and are regulated under the Clean Air Act as hazardous air pollutants. Wastes generated with the use of these solvents are regulated under the Resource Conservation and Recovery Act and must be controlled and disposed of at permitted facilities. By employing the use of ultrasonic cleaning in combination with various aqueous detergents, the ORNL Y-12 Plant has been successful in reducing their use of chlorinated solvents by 92% since 1987.

Value: Viable substitutes are needed for conventional chlorinated solvents at Army Depot maintenance cleaning operations.

Accomplishments to Date: The Army Environmental Center contracted with ORNL to evaluate maintenance cleaning operations at Army depots and to recommend or demonstrate solvent substitution technologies that might be useful. Corpus Christi, Anniston, and Red River Army Depots sent samples of contaminated equipment to ORNL to test the feasibility of using ultrasonic cleaning to degrease and remove baked on carbon deposits. Results indicated that ultrasonic cleaning with aqueous detergents was feasible for degreasing various parts and for cleaning very small openings. Although not independently effective in carbon removal, it was shown to improve overall cleaning times when contaminated parts were presoaked in various solutions before being agitated in ultrasonic tanks. It is anticipated that ultrasonic cleaning may also be effective in the process of paint removal.

Future Plans/Milestones:	
Procure and install a full-scale ultrasonic cleaning tank at Corpus Christi Army Depot	May 1994
Complete field testing of degreasing, carbon removal, and paint removal activities	June 1994
Complete final report and technology transfer package	August 1994

Available Documentation:

Technical report, **Solutions for the Chlorinated Solvent Debacle**, L.M. Thompson, R.F. Simandl, H.L. Richards, Oak Ridge National Laboratory, April 1991.

Suitability of PVC, Stainless Steel and Teflon Well Casings for Use in Groundwater Monitoring

Point of Contact: Martin H. Stutz (410) 671-1568, DSN 584-1568

Purpose: To determine if the type of well casing material has an effect on the capability to monitor for trace levels of organic and inorganic pollutants in groundwater.

Problem Addressed: Stainless steel, polyvinyl chloride (PVC), and teflon well casings have been used in the construction of groundwater monitoring wells. Concern has been expressed about whether the casing material used might influence the capability to measure trace levels of pollutants in groundwater. Prior to this work, very little data existed about how to select material that would neither absorb the pollutant, thereby lowering the measured value, nor release a quantity of the pollutant, thereby giving an artificially high result.

Value: The results of this task will facilitate the selection of well casing material that does not interfere with the trace level determination of pollutants in groundwater.

Accomplishments to Date: A prior study indicated that PVC was acceptable for groundwater wells in which trace levels of explosives were determined. In the current study, sorption tests on PVC, teflon, stainless steel 304, and stainless steel 316 have been conducted using groundwater containing a series of chlorinated organics, nitro-organics, Cd, Pb, As, and Cr.

Results to date indicate that teflon absorbs significant levels of chlorinated organics. PVC also absorbed measurable amounts of chlorinated organics, but the rates were much less than the teflon. Stainless steel was susceptible to oxidation upon exposure to groundwater. Rusting resulted in the formation of a ferric hydroxide precipitate that absorbed organic species and released minor and major constituents of the pipe material. For this reason, the capability to replicate inorganic measurements was poor, resulting in high analytical variances. Small losses of Pb from solution were observed for PVC over a 24-hour exposure. Overall though, it appears that PVC might be the best compromise if both organic and inorganic pollutants are to be determined in groundwater collected from a single well.

The aforementioned testing was performed in the static mode, i.e., a sample of casing material was placed in a container with contaminated water. In order to better match real conditions, tests are being conducted in the dynamic mode, with contaminated water flowing over the sample of casing material. Results show similar behavior between the static and dynamic modes. Additional studies were also performed using the extremes of concentration on the casing material, from ppb levels to high solvent concentration. Testing on other materials with ppm levels showed that fiberglass reinforced epoxy (FRE) behaves similar to PVC, while fiberglass reinforced plastic (FRP) and acrylonitrile butadiene styrene (ABS) behaved much worse. Future plans include an evaluation of acceptable materials that have higher concentrations of volatiles (solvents) and an evaluation of their behavior toward metals. The effect of chemicals on sampler materials will also be demonstrated.

It is to be noted that the acceptance of these results has been incorporated by the U.S. Environmental Protection Agency into its most recent guidance (RCRA Groundwater Monitoring: Draft Technical Guidance; EPA/530-R-93-001, 1992).

Future Plans/Milestones:	
Test for sorption/leaching of metals	September 1994
Behavior in presence of mixed/miscible solvents	August 1994
Demonstration of applicability of flexible samplers for organics	August 1994
Demonstration of decontamination of samplers	September 1995

Available Documentation:

Technical article, **Suggested Guidelines for the Use of PTFE, PVC, and Stainless Steel in Samplers and Well Casings,** ASTM STP 1118, Current_Practices in Groundwater and Vadose Zone Investigation, pp. 217-229.

Technical report, **Softening of Rigid Polyvinylchloride by High Concentrations of Aqueous Solutions of Methylene Chloride**, CRREL Special Report 92-12.

Technical article, **Dynamic Study of Common Well Screen Materials**, *Groundwater Monitoring and Remediation*, (In Press).

Technical article, **The Effects of Ground Water Samplers on Water Quality: A Literature Review**, *Groundwater Monitoring and Remediation*, (In Press).

Technical article, **The Effect of Concentration on Sorption of Dissolved Organics by Well Casings**, *Groundwater Monitoring and Remediation,* (In Press).

Technical report, **A Dynamic Study of Well Casing Materials**, CRREL Report 93-7.

Technical report, **Effect on Concentration on Sorption of Dissolved Organics by Well Casings**, CRREL Special report 93-8.

Technical report, **The Effects of Groundwater Monitoring Samplers on Water Quality - A Literature Review**, CRREL Special Report (In Press).

Technical report, **Suitability of ABS, FEP, FRE, and FRP Well Casings for Groundwater Monitoring: Part i. Literature Review and Sorption of Trace-Level Organics Study**. CRREL Special Report (In Press).

Technical report, **Softening of Rigid PVC by Aqueous Solutions of Organic Solvents**. CRREL Special Report (In Press)

Technical article, **Potential of Common Well Materials to Influence Aqueous Metal Concentrations**, *Groundwater Monitoring Review*, pp. 131-136, Spring 1992.

Supercritical Fluid Technologies

Point of Contact: Richard H. O'Donnell (410) 671-1589, DSN 584-1589

Purpose: To assess the technical and economic applicability of supercritical fluid (SCF) technologies to installation restoration (IR) activities.

Problem Addressed: U.S. Army production, maintenance, and training operations generate a wide variety of hazardous materials. Current regulatory constraints limit disposal options and call for the restoration of previous disposal sites. Available options for disposal and restoration are expensive and now consume a significant portion of operational budgets. As a result, the Army is seeking less costly alternatives for disposal and restoration. Additionally, hazardous waste controls are being sought for operations in which hazardous materials are still being generated.

Currently, SCFs are used for the following:

a. commercial extraction processes
b. adsorbent regeneration
c. the destruction of hazardous wastes.

Potential areas of application include the following:

a. synthetic resin regeneration
b. destruction of contaminants in sediments
c. destruction of contaminants in liquids
d. destruction of treatment sludges or surplus explosives.

The potential of SCF technologies was evaluated more than 10 years ago by the U.S. Army Toxic and Hazardous Materials Agency for application in the IR program. Conclusions at the time indicated that SCFs possessed a unique potential for applications where other technologies were ineffective. The relative immaturity of SCF technologies was cited at that time as the main reason that SCFs were not cost competitive with more mature technologies. The original effort will be used as a starting point.

Value: As a recently maturing technology, SCFs are identified as offering a potential cost savings over current IR technologies. The results of this study indicate, however, that for the majority of U.S. Army operations, SCFs are not a cost-effective treatment alternative. SCFs may provide a unique solution for certain applications where more established technologies have been found to be ineffective or publically unacceptable.

Accomplishments to Date: The study has been completed. An exhaustive literature search was undertaken, and numerous researchers and commercial equipment vendors were contacted and interviewed. Potential U.S. Army applications were identified, and cost estimates for implementation and operation were generated. The final report has been written and is in circulation for comments.

Future Plans/Milestones:	
Complete final report revisions	February 1994
Publish report	March 1994

Available Documentation:

Technical report, **Supercritical Carbon Dioxide Regeneration of Activated Carbon Loaded with Contaminants From Rocky Mountain Arsenal Well Water**, USATHAMA Report DRXTH-TE-CR-82160, May 1982.

Technical report, **Supercritical Fluid Technology Application Study**, USATHAMA Report DRXTH-TE-CR-82169, October 1982.

Technology Evaluation and Exchange

Point of Contact: Theodore E. Ruff (410) 671-1560, DSN 584-1560

Objective: To collect, analyze, and disseminate data about emerging remediation technologies in order to provide implementation guidance and expedite technology transfer.

Approach: As new technologies are developed, no one method provides a comprehensive means of evaluating the effectiveness of them, and of exposing them to the user community. This capstone effort is an attempt to compare emerging systems on an equal basis and provide the results of the comparison to the user as a package that can be implemented. The program begins at the close of the demonstration stage and culminates with consulting services for new technologies that were just put into operation. This transfer process is facilitated by technical analyses, handbooks, and formal data exchange programs.

Value: This program will provide implementation guidance and foster widespread acceptance of emerging technologies within the user and regulatory domains. This improved acceptance will lead to quicker and less costly restoration activities.

Accomplishments to Date: Data collection and analysis of a number of technologies are under way, and application analyses are being conducted. The annual U.S. Army Environmental Center Technology Symposium provides a vehicle for technology transfer and coordination. The Installation Restoration and Hazardous Waste Control Technologies Handbook serves as an example of the many published documents that help transfer technology to the user. A number of exchange programs also exist, such as those with the German and Canadian governments.

Future Plans/Milestones:	
Annual symposium	June 1994
Annual R&D program activities report	May 1994
Installation restoration and hazardous waste control technologies handbook update	June 1994
Data exchange efforts	As Required
Technology assessments	As Required

Available Documentation:

Technical article, **Technology Demonstration and Evaluation**, R. P. Bartell, L. Kanaras, and T. S. O'Rourke, *The Military Engineer*, August 1993.

Toxicity Evaluation of New Treatment Technologies

Point of Contact: Mark L. Hampton (410) 671-1559, DSN 584-1559

Purpose: To analyze the toxicity and biodegradation products from the composting of explosives-contaminated soils.

Problem Addressed: Composting to remediate explosives-contaminated soils is an emerging innovative technology. Composting has been selected as the remedial technology of choice to treat Umatilla Depot Activity's washout lagoon soils. Although the technology has demonstrated a significant reduction in toxicity to meet health risk based clean-up standards, the final fate of the biotransformation products and their ecological risk require further investigation. In addition, the occupational health risk associated with inhaling dust during a composting of explosives remediation needs to be addressed.

Value: Composting offers a cost-effective alternative to incineration of explosives-contaminated soils at sites with less than 20,000 tons of contaminated soil. This project is being conducted in support of the composting efforts at Umatilla Depot Activity (UMDA), Hermiston, Oregon.

Accomplishments to Date: The U.S. Army Biomedical Research and Development Laboratory (USABRDL) is directing the activities of the Oak Ridge National Laboratory (ORNL) in evaluating the environmental impact of the compost product. Initial toxicological studies that were completed on compost from Louisiana Army Ammunition Plant (LAAP) indicated composting can reduce the level of toxicity to acceptable levels.

In phase II, static pile and mechanically stirred composts from the UMDA composting optimization study were characterized chemically and toxicologically. The main conclusion of the study is that composting can effectively remediate explosives-contaminated soils and sediment. However, low levels of explosives and biotransformation products, bacterial mutagenicity, and leachable toxicity to ceriodaphnia may remain after composting. The sources of the residual toxicity and mutagenicity are unknown. In addition, radiolabled trinitrotoluene (TNT) composting experiments show that TNT is biotransformed and a hydrolyzable, non-extractable, insoluble fraction is observed.

Future work needs to be done to determine the environmental significance of this finding by identifying the structures of the insoluble fraction and establishing their potential for release into the environment.

Future Plans/Planned Milestones:

Final report on inhalation hazard of dust from composting of explosives operations	September 1993
Final report on identification of the insoluble fraction and its potential environmental availability	September 1994

Available Documentation:

Technical report, **Characterization of Explosives Processing Waste Decomposition Due to Composting**, U.S. Army Report ORNL/TM-11573, January 1990.

Technical report, **Phase II, Characterization of Explosives Processing Waste Decomposition Due to Composting**, U.S. Army Report ORNL/TM-12029, November 1991.

Technical report, **Characterization of Explosives Waste Decomposition Due to Composting**, September 1993.

Transportable Hot Gas Decontamination

Point of Contact: Louis Kanaras (410) 671-1558, DSN 584-1558

Purpose: To develop and implement a transportable, cost-effective, safe, and environmentally acceptable method for decontaminating small process equipment and excavated underground piping and sewer systems that are contaminated with explosives/propellants.

Problem Addressed: The current method of decontaminating excavated underground piping is by manual use of a flamethrower held at one end of the piping. This method leads to uncontrolled air emissions, is a personnel hazard, and has minimal/crude quality control associated with the decontamination effectiveness achieved.

Value: This new transportable hot gas decon technology will do the following:

a. generate controlled "regulatory acceptable" emissions
b. reduce personnel hazards
c. have a quality control/assurance program associated with it.

Cleanup of energetic contaminated piping is a significant problem in the installation restoration effort. At the West Virginia Ordnance Works, a formerly used defense site, seven miles of piping were recently excavated and decontaminated.

Accomplishments To Date: Significant progress has been made in the development of hot gas decon technology that decontaminates large energetic-contaminated process equipment and structural components. In addition to studies of decontamination of chemical agent-contaminated facilities, down-sizing of this equipment is being investigated. There is a need for a transportable hot gas decon system that can be taken from installation to installation to remediate energetic-contaminated piping and sewer systems and small process equipment.

This program is a new start. Preliminary activities have included submission of a task order solicitation through a current task order contract. Roy F. Weston has submitted a proposal, and the Government is currently negotiating to award the subject contract.

Future Plans/Milestones:	
Program plan	March 1994
Site selection	April 1994
Equipment selection	May 1994
Equipment purchase	June 1994
Test plan	July 1994
Equipment installation complete	August 1994
Begin pilot test	November 1994
Complete testing	February 1995
Final report/video	May 1995
Cost analysis	September 1995
Finalize procurement fabrication data	January 1996

Available Documentation:

Technical report, **Development of Novel Decontamination and Inerting Techniques for Explosives-Contaminated Facilities, Phase I - Identification and Evaluation of Novel Decontamination Concepts,** USATHAMA Report AMXTH-TE-TR-83211, July 1983.

Technical report, **Development of Novel Decontamination and Inerting Techniques for Contaminated Facilities, Phase II - Laboratory Evaluation of Novel Explosives Decontamination Concepts,** USATHAMA Report AMXTH-TE-TR-85009, March 1985.

Technical article, **Design Support for a Hot Gas Decontamination System for Explosives-Contaminated Buildings,** Maumee Research and Engineering, April 1986.

Technical report, **Pilot Plant Testing of Caustic Spray/Hot Gas Building Decontamination Process,** USATHAMA Report AMXTHE-TE-CR-87112, August 1987.

Technical report, **Task Order - 2, Pilot Test of Hot Gas Decontamination of Explosives-Contaminated Equipment at Hawthorne Army Ammunition Plant (HWAAP), Hawthorne, Nevada** Report CETHA-TE-CR-90036, July 1990

Transportable Thermal Desorption Gas Chromatography/Mass Spectrometry

Point of Contact: George E. Robitaille (410) 671-1576, DSN 584-1576

Purpose: To achieve qualitative and quantitative determinations of organic contaminants on site.

Problem Addressed: The amount of contamination present on site is determined far too late. Using this technology, contamination would be assessed earlier. An earlier assessment will help determine the level of protection needed for the people involved in sample collection. Another advantage of using this type of analysis is that the contour map for the contamination on sites will be prepared faster and more accurately, which will help shorten the time required to clean up contaminated sites.

Value: This technique will allow for field analysis of a soil or water sample in approximately 15 minutes. The rapid analysis would permit field screening of samples and allow for rapid decision-making on site. The ability to make near real-time decisions would considerably reduce the time and costs associated with site characterization.

Accomplishments to Date: Results of studies using this technology are comparable to those obtained by U.S. Environmental Protection Agency (EPA) contractors. A field study of volatile contaminants has been completed at Fort Devens, MA. Laboratory methods have been developed for the analysis of explosives.

Future Plans/Milestones:	
Conduct field study of explosives in soil and water	June 1994
Evaluate transition of this technology to the cone penetrometer	September 1994

Available Documentation:

Technical paper, **Thermal Desorption Gas Chromatography-Mass Spectrometry Field Methods for the Detection of Organic Compounds**, A. Robbat, Jr., T-Y Liu, B. Abraham, and C-J Liu, Second International Symposium, Field Screening Methods for Hazardous Waste and Toxic Chemicals, 12-14 February 1991, Tufts University.

Technical report, **On-Site Thermal Desorption Gas Chromatography/Mass Spectrometry of Organic Compounds at Fort Devens, MA**, December 1993.

Treatment of DNT in Propellant Production Waste Waters

Point of Contact: Edward G. Engbert (410) 671-1575, DSN 584-1575

Purpose: To demonstrate and evaluate alternative treatment technologies that could effectively reduce or eliminate the discharge of dinitrotoluene (DNT) in propellant production waste water at the Radford Army Ammunition Plant (RAAP).

Problem Addressed: DNT is a byproduct from the manufacture of propellants at RAAP and is found in waste water resulting from these operations. Influent at the existing waste water treatment facility contains concentrations of DNT of as much as 75 mg/L and is unable to satisfy discharge limits at all times. DNT is a suspected carcinogen and has been linked to heart disease in some studies. Proposed regulatory discharge levels have been reduced to 113 µg/L.

Value: Field pilot demonstrations will identify the most successful technologies for reducing discharge levels of DNT to acceptable levels. Implementation of these technologies in the future will allow DNT propellant production operations at RAAP to remain in compliance with environmental discharge regulations.

Accomplishments to Date: Hercules, Inc., conducted a study at RAAP in 1990 that assessed a number of potential treatment technologies for removal of DNT from waste water, including biodegradation, ultraviolet (UV)/ozone oxidation, and absorption of DNT on granular activated carbon (GAC). Further study was recommended for biodegradation and UV/ozonation since they are both destructive technologies. Bench-scale tests conducted by the U.S. Army Construction Engineering Research Laboratories (CERL) in 1992 have shown that biodegradation with anaerobic biological GAC (AnBAC) contactors is a successful mechanism for removing DNT from influent waste water. Technologies selected for demonstration at RAAP include the use of an AnBAC followed by an aerobic rotating biological contractor system, as well as the use of UV light with various combinations of ozone and hydrogen peroxide.

Future Plans/Milestones:	
Procure the demonstration equipment and have assembly and testing initiated	May 1994
Final results and a report supporting full-scale selection and design	November 1994

Available Documentation:

Technical report, **Treatment of Propellant Production Waste Water Containing DNT Using Expanded Bed Granular Activated Carbon Reactors**, U.S. Army Construction Engineering Research Laboratories, Champaign, IL; M. Suidan, S. Berchtold, Univ. of Cincinnati, Cincinnati, Ohio.

Technical report, **Removal of DNT from Waste Waters at Radford Army Ammunition Plant**, USATHAMA Report CETHA-TS-CR-91031, March 1991.

Trinitrotoluene (TNT) Sensor Development

Point of Contact: George E. Robitaille (410) 671-1576, DSN 584-1576

Purpose: Develop a cone penetrometer-compatible TNT sensor.

Problem Addressed: Current methods require samples to be collected and shipped to an off-site laboratory for analysis. The current procedure is costly and time consuming.

Value: This sensor will provide the capability to do a site characterization for TNT contamination (and possibly other types of explosives) in a more efficient and cost effective manner.

Accomplishments to Date: Preliminary laboratory sensor tests indicate parts-per-billion detection capabilities for nitric oxide and nitrogen dioxide vapors.

Future Plans/ Milestones:	
Laboratory testing of pyrolysis products of TNT	December 1993
Fabrication of prototype sampler	January 1994
Prepare homogeneous soil standards	January 1994
Develop lab test protocol	February 1994
Develop field test protocol	March 1994

Available Documentation: None

Unexploded Ordnance Detection

Point of Contact: Kelly A. Rigano (410) 671-1557, DSN 584-1557

Purpose: To develop, evaluate, and implement technology with the capability to detect, locate, and identify buried unexploded ordnance (UXO).

Problem Addressed: Millions of acres of Army real estate are contaminated with UXO. In order to meet installation restoration and base realignment and closure requirements, UXO detection and removal is necessary. Current technology is labor intensive, time consuming, and costly. Also, current UXO surveying techniques have been impeded by limited sensor selection and application options.

Value: Detection systems will allow the Army and other Department of Defense (DOD) agencies to more safely, more accurately, and more economically locate (and ultimately dispose of) UXO.

Accomplishments to Date: The U.S. Army Environmental Center (USAEC) has developed the Surface Towed Ordnance Locator System (STOLS) for detection, characterization, and location of subsurface UXO. This system incorporates an array of seven cesium vapor magnetometers, and uses a precision differential global positioning system. The USAEC has successfully transferred this technology; the STOLS technology is now commercially available for site investigations.

The USAEC has also joined with two Department of Energy (DOE) laboratories to develop the Remote Characterization System (RCS). The RCS, part of DOE's Buried Waste Integrated Demonstration Program, is a remotely operated vehicle that carries a fused array of sensing technologies for detecting ordnance and other hazardous materials.

Future Plans/Milestones:

The USAEC has a comprehensive group of systems currently being developed. In order to survey large parcels of land in a short period of time, airborne ground-penetrating radar (GPR) is being constructed to identify UXO. The USAEC is also managing the development and demonstration of the Surface Ordnance Characterization System (SOCS). The SOCS will incorporate magnetometers and GPR onto a remotely operated platform. Sensor fusion and target discrimination processing will be incorporated into the system. A man-portable sensor device is being constructed to transfer and gather data in areas where SOCS cannot. The result from the two systems will be a comprehensive coordinated UXO survey. Data from these UXO detection systems will be transferred directly to the USAEC excavator for target reacquisition. Demonstrations of this technology will occur from April through July 1994.

Available Documentation:

Technical report, **Range Clearance Technology Assessment (Revision 1),** NAVEODTECHCEN Technical Report, March 1990.

Technical report, **Remote Detection of Unexploded Ordnance - Surface Towed Ordnance Locator Systems (STOLS),** NAVEODTECHCEN Technical Report TR-302, September 1991.

Technical report, **UNDEX Site Survey Report,** NAVEODTECHCEN Technical Report TR-303, September 1991.

Technical report, **Remote Detection of Unexploded Ordnance - Ground Penetrating Radar,** NAVEODTECHCEN Technical Report TR-308, February 1992.

Unexploded Ordnance Removal

Point of Contact: Kelly A. Rigano (410) 671-1557, DSN 584-1557

Purpose: To develop, evaluate, and implement technology that will enhance the capability to remediate buried unexploded ordnance.

Problem Addressed: Millions of acres of Army real estate are contaminated with unexploded ordnance (UXO). In order to meet installation restoration and base realignment and closure requirements, UXO remediation is necessary. Current excavation and disposal technology is labor intensive, time consuming, and costly.

Value: New technology will allow the Army and other Department of Defense (DOD) agencies to more safely and economically dispose of unexploded ordnance.

Accomplishments to Date: The U.S. Army Environmental Center (USAEC) is in the process of modifying an excavator to be used for UXO remediation. This system, a spin off of the Air Force's Rapid Runway Repair Program, will incorporate autonomous control and advanced navigation with collision avoidance. Data from the USAEC UXO detection systems will flow directly to this remediation system for target reacquisition.

Future Plans/Milestones:	
USAEC excavator demonstration in conjunction with USAEC UXO detection systems	April - July 1994

Available Documentation:

Technical report, **Range Clearance Technology Assessment (Revision 1),** NAVEODTECHCEN Technical Report, March 1990.

PROGRAM PERFORMERS

FY93 PERFORMERS FOR THE U.S. ARMY ENVIRONMENTAL CENTER ENVIRONMENTAL R&D PROGRAM

Argonne National Laboratory	Argonne, IL
Arthur D. Little, Inc.	Edgewood, MD
Battelle Columbus Laboratories	Columbus, OH
Battelle Pacific Northwest Laboratories	Richland, WA
Concurrent Technologies	Johnstown, PA
Engineer-Science Inc.	Denver, CO
Day Zimmerman and Basil, Inc.	Hawthorne, NV
Oak Ridge National Laboratory	Oak Ridge, TN
Engineering Science	Denver, CO
Hercules Inc.	Radford, VA
Idaho National Engineering Laboratory	Idaho Falls, ID
IT Corporation	Cincinnati, OH
National Defense Center for Environmental Excellence	Johnstown, PA
Naval EOD Technology Center	Indian Head, MD
Naval Surface Warfare Center	Indian Head, MD
Parsons	Pasadena, CA
Roy F. Weston, Inc.	West Chester, PA
Tennessee Valley Authority	Muscle Shoals, AL
Tobyhanna Army Depot	Tobyhanna, PA
Tufts University	Medford, MA
U.S. Army Waterways Experiment Station	Vicksburg, MS

U.S. Army Cold Regions Research and Engineering Laboratory	Hanover, NH
U.S. Army Construction Engineering Research Laboratories	Champaign, IL
Science and Technology Corporation	Hampton, VA
Stone and Webster Environmental Technology and Services	Boston, MA
Umatilla Army Depot Activity	Hermiston, OR
University of Akron	Akron, OH
University of Delaware	Wilmington, DE

FORMAL TECHNOLOGY TRANSFER PRESENTATIONS

PRESENTATIONS FOR FY93

"Pollution Prevention Technologies," Mr. Richard Eichholtz, Joint Depot Environmental Panel Meeting, 21 October 1992, Norfolk Naval Shipyard, Virginia.

"Composting of Explosives-Contaminated Soil," MAJ Timothy O'Rourke, EPA Innovative Hazardous Waste Treatment Technologies Forum, 18 November 1992, San Francisco, California.

"Composting of Explosives-Contaminated Soil at Umatilla Army Depot Activity," Mr. Wayne Sisk, Composting Workshop at Washington State University, 10 December 1992, Pullman, Washington.

"USAEC Technology Development Program," Mr. Erik Hangeland, Foriegn Science and Technology Center, Environmental Technology Committee, 5 January 1993, Washington, DC.

"Implementation of Compliance Technologies," Mr. Richard Eichholtz, JDEP Meeting, 2 February 1993, Corpus Christi Army Depot, Texas.

"SCAPS Program, San Antonio, Texas. U.S. Army Technology Transfer Opportunities," Mr. Richard Eichholtz, Joint SBIR Planning Meeting, 2 March 1993, Baltimore, Maryland.

"UV Oxidation Treatment and Activated Carbon Treatment of Explosive-Contaminated Water," Mr. Wayne Sisk, EPA Seminar on Technologies for Remediating Sites Contaminated with Explosive and Radioactive Wastes, 2-3 March 1993, Omaha, Nebraska.

"National Environmental Test Site Program for Explosives-Contaminated Soil and Ground Water," Ms. Julia O'Rourke, DOD Environmental Technology Transfer Committee, 10 March 1993, Tyndall Air Force Base, Flordia.

"Combined Hot Gas Decon Systems (Energetics and Chemical Agents)," MAJ Timothy O'Rourke, American Defense Preparedness Association Conference, 24 March 1993, Albuquerque, New Mexico.

"USAEC Technology Development Program," Mr. Erik Hangeland, DOE Environmental Technology Transfer Forum, 5 April 1993, Washington, DC.

"The Site Characterization and Analysis Penetrometer System Workshop Program," Mr. Richard O'Donnell, Conference on Metrology for Environmental Management at the National Institute of Standards and Technology, 14-15 April 1993, Washington, DC.

"Reuse of Waste Energetics as a Supplemental Fuel," Mr. Louis Kanaras, Earth Day, 22 April 1993, Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland.

"SCAPS Sensor Development and Field Analysis Instrumentation Efforts," Mr. George Robitaille, Project Monitor Workshop, 5 May 1993, Vicksburg, Mississippi.

"Combined Hot Gas Decon Systems (Energetics and Chemical Agents)," MAJ Timothy O'Rourke, Federal Environmental Restoration Conference, 25 May 1993, Washington, DC.

"Field Demonstration of Windrow Composting for Explosives-Contaminated Soil," MAJ Kevin Keehan, the Third USACE Innovative Technology Transfer Workshop, 22-23 June 1993, Williamsburg, Virginia.

"National Test Site Program For Explosives-Contaminated Soil and Ground Water," Ms. Julia O'Rourke, 17TH Annual Army Environmental R&D Symposium and Third USACE Innovative Technology Transfer Workshop, 22-24 June 1993, Williamsburg, Virginia.

"Biological Treatment Methods for Soils and Sludges Contaminated with Explosives" and **"Unsuccessfully Demonstrated Technologies for Explosives Waste,"** MAJ Kevin Keehan, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosives and Radioactive Wastes, 20-21 July 1993, Sacramento, California.

"Overview of Sources of Explosive Contamination," Mr. Wayne Sisk, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosive and Radioactive Wastes, 20-21 July 1993, Sacramento, California.

"UV/Oxidation Treatment and Activated Carbon Treatment of Explosive-Contaminated Water," Mr. Wayne Sisk, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosive and Radioactive Wastes, 20-21 July 1993, Sacramento, California.

"Biological Treatment Methods for Soils and Sludges Contaminated with Explosives" and **"Unsuccessfully Demonstrated Technologies for Explosives Waste"** MAJ Kevin Keehan, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosives and Radioactive Wastes, 22-23 July 1993, Dallas, Texas.

"Overview of Sources of Explosive Contamination," Mr. Wayne Sisk, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosive and Radioactive Wastes, 22-23 July 1993, Dallas, Texas.

"UV/Oxidation Treatment and Activated Carbon Treatment of Explosive-Contaminated Water," Mr. Wayne Sisk, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosive and Radioactive Wastes, 22-23 July 1993, Dallas, Texas

"Energetics Remediation and Technology Development," MAJ Timothy O'Rourke, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosive and Radioactive Wastes, 2-3 August 1993, Chicago, Illinois.

"Biological Treatment Methods for Soils and Sludges Contaminated with Explosives" and **"Unsuccessfully Demonstrated Technologies for Explosives Waste"** MAJ Kevin Keehan, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosives and Radioactive Wastes, 5-6 August 1993, Honolulu, Hawaii.

"Biological Treatment Methods for Soils and Sludges Contaminated with Explosives" and **"Unsuccessfully Demonstrated Technologies for Explosives Waste,"** MAJ Kevin Keehan, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosives and Radioactive Wastes, 18-19 August 1993, Atlanta, Georgia.

"Reactivity Testing of Explosives-Contaminated Soil," Mr. Wayne Sisk, Nevada Department of Environmental Protection, 12 August 1993, Carson City, Nevada.

"USAEC Transferable Technologies for Depot Operations," Mr. Richard Eichholtz, USAMC Lessons Learned Workshop, 24 August 1993, Davenport, Iowa.

"Biological Treatment Methods for Soils and Sludges Contaminated with Explosives" and **"Unsuccessfully Demonstrated Technologies for Explosives Waste,"** MAJ Kevin Keehan, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosives and Radioactive Wastes, 24-25 August 1993, Newark, New Jersey.

"Unsuccessfully Demonstrated Technologies for Treating Explosives-Contaminated Soil," Mr. Wayne Sisk, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosive and Radioactive Wastes, 26-27 August 1993, New Carrollton, Maryland.

"Biological Treatment Methods for Soils and Sludges Contaminated with Explosives," Mr. Mark Hampton, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosives and Radioactive Wastes, 26-27 August 1993, New Carrollton, Maryland.

"Overview of Sources of Explosive Contamination," and **"UV/Oxidation Treatment and Activated Carbon Treatment of Explosives-Contaminated Water,"** Mr. Wayne Sisk, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosive and Radioactive Wastes, 26-27 August 1993, New Carrollton, Maryland.

"Reuse of Waste Energetics as a Supplemental Fuel," Mr. Louis Kanaras, 1 September 1993, Holston Army Ammunition Plant, Kingsport, Tennessee.

"Biological Treatment Methods for Soils and Sludges Contaminated with Explosives" and **"Unsuccessfully Demonstrated Technologies for Explosives Waste,"** MAJ Kevin Keehan, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosives and Radioactive Wastes, 8-9 September 1993, Boston, Massachusetts.

"Unexploded Ordnance Detection, Analysis, & Remediation Technology Transfer Update," Ms. Kelly Rigano, Western Governor's Association, 9 September 1993, Denver, Colorado.

"Biological Treatment Methods for Soils and Sludges Contaminated with Explosives" and **"Unsuccessfully Demonstrated Technologies for Explosives Waste,"** MAJ Kevin Keehan, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosives and Radioactive Wastes, 13-14 September 1993, Salt Lake City, Utah.

"Biological Treatment Methods for Soils and Sludges Contaminated with Explosives," Mr. Mark Hampton, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosives and Radioactive Wastes, 16-17 September 1993, Anchorage, Alaska.

"Unsuccessfully Demonstrated Technologies for Explosives Waste," MAJ Kevin Keehan, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosives and Radioactive Wastes, 16-17 September 1993, Anchorage, Alaska.

"U.S. Army Environmental Center: Technology Transfer Initiatives and Research and Development Program," Ms. Julia O'Rourke, Eighth Annual Conference on Contaminated Soils, 20-23 September 1993, University of Massachusetts at Amherst, Massachusetts.

"Windrow Composting Field Demonstrations for Explosives-Contaminated Soils," Ms. Julia O'Rourke, Eighth Annual Conference on Contaminated Soils, 20-23 September 1993, University of Massachusetts at Amherst, Massachusetts.

"Energetics Remediation and Technology Development," MAJ Timothy O'Rourke, EPA/DOD Seminar on Technologies for Remediating Sites Contaminated with Explosives and Radioactive Wastes, 22-23 September 1993, Chicago, Illinois.

"Field Demonstration of Windrow Composting for Explosives-Contaminated Soil," MAJ Kevin Keehan, 1993 U.S.-Germany Data Exchange Meeting on Environmental Technology, 5-7 October 1993, San Antonio, Texas.

"Extraction and Chromatographic Development of Selected Organophosphorus Compounds from Soil and Aqueous Media," Mr. Tony Perry, 29 October 1993, U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland.

"Thermal Treatment Technologies: The Remediation of Explosives-Contaminated Soils by Rotary Kiln Incineration," Mr. Theodore Ruff, Workshop on Explosives-Contaminated Soils Remediation and Characterization sponsored by the Environmental Performance Cooperative, 20-22 October 1994, Chattanooga, Tennessee.